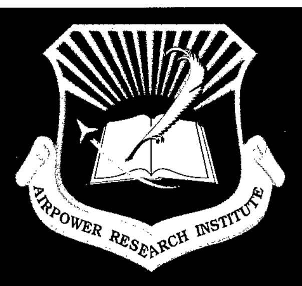
AIRPOWER RESEARCH INSTITUTE



Hitting a Bullet with a Bullet

A History of Ballistic Missile Defense

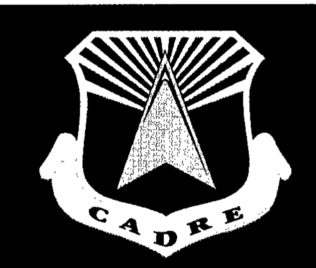
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Most of all, this study was made possible by the support of my wife Jeanne.

Note to the Reader

I have used both English and metric units throughout the text as the data appeared in the source material. While this violates the rule of consistency, it avoids introducing errors of conversion from the original sources. A conversion table is included for those inclined to change from one measure to the other.

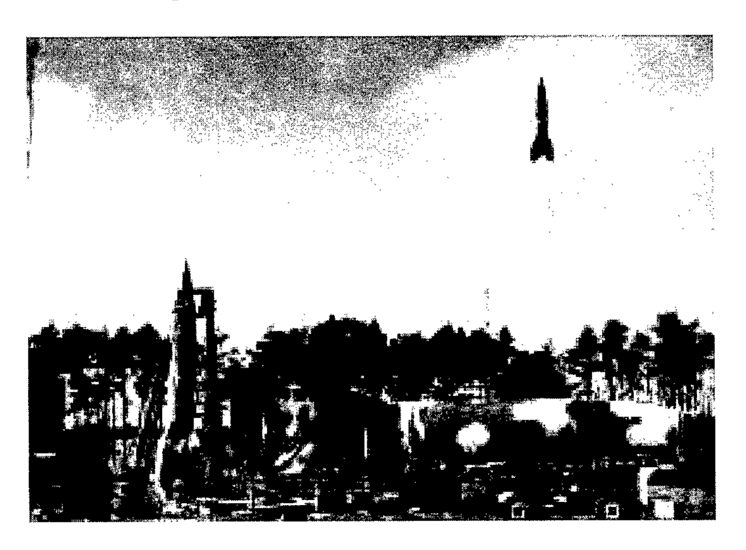
I have also used dollar figures as indicated in the original sources.

The text covers a large number of organizations and technologies. To help the reader, I have spelled out the entire phrase at its first appearance in each chapter. In addition, I have included all of these abbreviations in the glossary.

Contents

Ballistic Missile Defense: The Early Years to 1972

In mid-1944 the Germans lashed out at the war-weary British civilians with their wonder weapons, both air breathing winged missiles (V-1s) and supersonic ballistic missiles (V-2s). The first V-1 Buzz Bomb impacted on British soil in June 1944, followed by the first V-2s in September. The Germans launched about 8,200 V-1s against Great Britain and another 7,800 against continental targets, they also hit Britain with 1,100 V-2s and continental targets with almost 1,700.[1]



German V-2 missile activity at Peenumunde during World War II. The V-2 campaign was the first and largest ballistic missile campaign yet seen. Credit: US Army Aviation and Missile Command

In contrast to the eventual successful defense against the German V-1 flying bomb, Allied efforts against the V-2 ballistic missile proved futile.[2] The air campaign against the V-2s began with a Royal Air Force strike in August 1943 on the German experimental missile facility at Peenemunde that had little effect on the Germans other than to alert them to the fact that the Allies were aware of their operations and plans, and to encourage them to disperse their facilities. The Allies went on to bomb a number of missile manufacturing factories, however, only two of the ten vulnerable and valuable fuel plants were hit, and these with little result. According to the most credible authority on the bombing of Germany, "these attacks apparently had little effect on output."[3] The

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The last entry in the citation indicates the location of archival material. AUL, Air University Library, Maxwell AFB, AL; HRA, Historical Research Agency, Maxwell AFB, AL; and RSIC, Redstone Scientific Information Center, Redstone Arsenel, AL. While some of this material was taken from classified documents, all of the excerpted material was unclassified.

[1] United States Strategic Bombing Survey, *Over-all Report (European War)* ([Washington]: n.p., 1945), 88.

[2] The Allies downed 53 percent of the V-1s observed. Kenneth Werrell, *Archie, Flak, AAA, and SAM* (Maxwell AFB: Air University, 1988), 18-19.

[3] USSBS, *Overall Report*, 88; Adam Gruen, *Preemptive Defense: Allied Air Power Versus Hitler's V-Weapons, 1943-1945* (Washington: Air Force History and Museums Program, 1998), 15.

Allied air forces also exerted considerable force against the launching sites and storage depots for both weapons but without a positive outcome. Although the V-weapons campaign consumed 9 percent of the Allied bomb tonnage during the 13-month period between August 1943 and the summer of 1944, the bombing delayed the V-1 offensive no more than three-to-four months and had no impact on the V-2s. Despite total air dominance, the Allied air forces never found or successfully attacked a single German V-2 launch unit. Although a large device, 46 feet in length and weighing about 27,000 pounds at lift off, it proved mobile and elusive. Technical difficulties delayed the V-2s, not the bombing.[4]

Downing ballistic missiles after launch was essentially impossible. According to one secondary source, however, there were two such shoot-down opportunities during the war. In the first, a Spitfire pilot flying low over Holland saw a V-2 rising after launch and fired at it without success. The second incident involved B-24s of the 34th Bomb Group that were returning from a bombing mission at 10,000 feet over the low countries when a V-2 flew through the formation. A waist gunner fired his .50-caliber machine gun at the missile, and claimed credit for its destruction.[5] Both incidents may have occurred, certainly make for good stories, but, alas, neither can be confirmed. There is documentation, however, of British investigations of the concept of firing an artillery barrage into the missile's path after the defenders were alerted by radar. The calculations indicated that it would require 320,000 shells to down one V-1, a rather expensive exercise. It also would have been counterproductive, for the British expected that about 2 percent of the shells would not detonate as planned, and that these duds and the debris from the exploding shells would return to earth. There were fears that this rain of metal would cause more casualties than would the V-2s that might be intercepted. In any case, the British estimated that they could destroy 3 to 10 percent of the V-2s they engaged.[6]



V-2 being tested at White Sands, New Mexico. Credit: US Army Aviation and Missile Command

The Air Force expressed interest in both the offensive and defensive aspects of the ballistic missile, however, the establishment of the USAF in 1947 complicated matters. On the offensive side, initially the Air Force acquired missiles that were winged, while the Army got ballistic missiles, based on the principle that winged

[4] Robert Allen, "Counterforce in World War II," 109 in *Theater Missile Defense: Systems and Issues—1993* (Washington: American Institute of Aeronautics and Astronautics, 1993); Military Intelligence Division, Handbook on Guided Missiles of Germany and Japan, Feb 1946, RSIC; USSBS, *Overall Report*, 88-89.

[5] David Johnson, *V-1, V-2: Hitler's Vengeance on London* (NY: Stein and Day, 1981), 168-69.

[6] Donald Baucom, *The Origins of SDI, 1944-1983* (Lawrence, KS: University Press of Kansas, 1992), 4; Frederick Pile, *Ack-Ack: Britain's Defence Against Air Attack During the Second World War* (London: Harrap, 1949), 388.

missiles are related to aircraft and ballistic missiles to artillery. On the defensive side, the antiaircraft function remained with the ground service. (One author claims this was because the airmen did not want to bring in the Coast Artillery officers who manned the guns, as they had seniority.[7]) Concurrently, the US military was looking into ballistic missile defense. In July 1945 an Army team returned from a European study of the V-2 campaign to recommend a ballistic missile defense research and development program. In late 1945 the Army Air Forces (AAF) Scientific Advisory Board raised the issue of ballistic missile defense. That was followed in May 1946 by a report from the War Department Equipment Board, headed by the famous General "Vinegar" Joe Stilwell, that echoed this concern and urged that defense against atomic weapons be given top defense priority.[8]

In March 1946 the AAF began two missile defense projects. The first was manufactured by General Electric and called Project THUMPER (MX-795). It used the Army's Bumper, consisting of a V-1 rocket as a first stage and a WAC Corporal as a second stage, on several tests. The USAF cancelled THUMPER in March 1948. The University of Michigan was responsible for the second, Project WIZARD (MX-794) that was to defend against missiles of speeds of up to 4,000 mph and altitudes between 60,000 and 500,000 feet.[9] WIZARD continued as the AAF's, than USAF's, entry in the bid to get a ground-to-air defensive capability and was pitted against the Army's NIKE project. Initially, WIZARD was seen as a weapon to defend the continental United States, while NIKE was intended for theater operations. In the early 1950s the USAF was thinking in terms of an interceptor with a range of 30 nm that could defend an area 18 nm in diameter. While the Air Force believed it had a superior technology, WIZARD's development trailed the Army's NIKE missile. In 1958 the Air Force conceded it was too costly and thus the Department of Defense (DoD) merged it with the NIKE-ZEUS project.[10]

The Army had been working the antiaircraft problem since the dawn of aviation. Therefore it was only natural to apply rocket development to counter aircraft. In early 1944 the Army Ground Forces sent the Army Service Forces[11] a request for the development of a directly controlled, large, "antiaircraft rocket torpedo," or in more modern language, a surface-to-air missile (SAM). The Army rolled the requirement into

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[7] B. Bruce-Briggs, *The Shield of Faith: A Chronicle of Strategic Defense from Zeppelins to Star Wars* (NY: Simon and Schuster, 1988), 47-48.

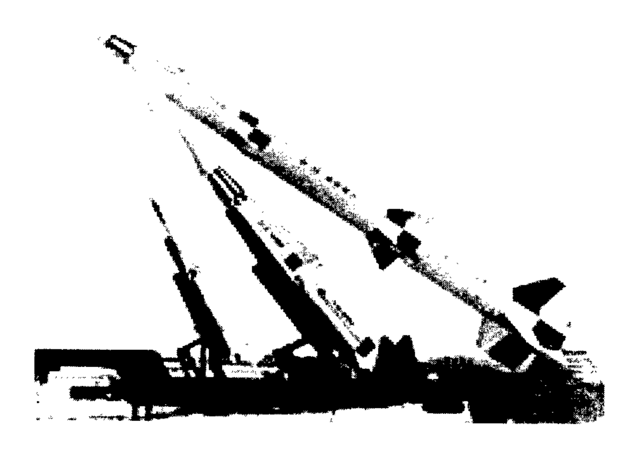
[8] Baucom, *Origins of SDI*, 4,6.

[9] As explained in the "Note to the Reader," I have used the measures indicated by the original source instead of changing these to a standard measurement. A conversion table is included after the text.

[10] Army Ordnance Missile Command, Surface-to Air Missiles Reference Book, V-1, 2 RSIC; Stephen Blanchette, "The Air Force and Ballistic Missile Defense," Air Command and Staff College thesis, Feb 1987, 10-11,15-16 AUL MU 43222B6411a; Baucom, *Origins of SDI*, 6,12-13; Georgia Institute of Technology, "Missile Catalog: A Compendium of Guided Missile and Seeker Information," Apr 1956, 101,128,130 RSIC; History of Air Research and Development Command: Jul-Dec 1954, vol.1, 225-27 HRA K243.01; James Walker, Frances Martin, and Sharon Watkins, *Strategic Defense: Four Decades of Progress* (n.p.: Historical Office, U.S. Army Space and Strategic Defense Command, 1995), 4.

[11] During World War II the US Army was organized into three major components: Army Air Forces, Army Ground Forces, and Army Service Forces.

NIKE Missiles: AJAX, HERCULES, and ZEUS



Nike family, America's first surface-to-air missiles. From front to rear: NIKE-ZEUS, NIKE-HERCULES, NIKE-AJAX. Credit: US Army Aviation and Missile Command

an ongoing study of guided missiles. The Army Service Forces approved the development of antiaircraft missile in late January 1945 and about a week later the government awarded Western Electric (a subsidiary of Bell Telephone Laboratories) a study contract. The missile was to be capable of intercepting a 600-mph bomber, flying between 20,000 and 60,000 feet, at a maximum (ground) range of 12 miles.[12]

The Army named the system "NIKE" after the Greek goddess of victory. Progress was slow during the 1940s, but in the wake of the Korean War, more precisely in January 1951, the Army accelerated research and development. That November a NIKE successfully intercepted a target drone, followed by successful destruction of others in April 1952. The Army deployed the missile, now known as the NIKE AJAX, in March 1954. By the middle of 1958 these SAMs had almost replaced antiaircraft artillery as America's ground-based strategic air defense. The larger, heavier, and better performing NIKE HERCULES went into service in June 1958, gradually replacing the AJAX that was eventually phased out of the US inventory in 1964.[13] The chief advantage the new missile brought to the table was its atomic warhead, increasing the missile's lethality from tens of feet to hundreds of feet.[14]

At the same time the Army was making progress on the issue of ballistic missile defense. In January 1949 the Army established a formal requirement for ballistic missile defense that early in 1951 spawned the PLATO Project. It was to provide anti-ballistic missile (ABM) protection for the field army against short and medium range ballistic

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[12] Mary Cagle, "Historical Monograph: Development, Production, and Deployment of the Nike Ajax Guided Missile System, 1945-1959," circa Jun 1959, 1-4 RSIC.

[13] Cagle, "Nike Ajax," 112,116-17,125,181,200-02; Mary Cagle, "History of the Nike Hercules Weapon System," circa Apr 1973, v,7-8,42 RSIC.

[14] One of the major reasons for using an atomic warhead was that the AJAX radar had difficulty separating out individual targets that were in close proximity, namely, aircraft flying in formation. The HERCULES also could be fitted with a fragmentation warhead. Cagle, "Nike Hercules," 39,200.

missiles.[15] In 1954 the Army determined that a defense against intercontinental ballistic missiles (ICBMs) was needed for the 1960-70 timeframe. A number of studies emerged, one in 1955 recommended a continuously guided missile armed with a nuclear warhead. Another study the next year suggested using a NIKE ZEUS variant. PLATO was shut down in 1959, not for technical reasons, but because of funding problems.[16]

The follow on to PLATO was the Field Army Ballistic Missile Defense System (FABMDS) program that began in 1959. But this had a long lead time, with an expected operational date of 1967. Therefore the Army sought other equipment to fulfill its needs. Early on, the Army considered using HAWK in this role and achieved test success when, a HAWK intercepted a short-range HONEST JOHN ballistic missile.[17] The Army wanted more, but settled for the NIKE HERCULES as an interim system. An Improved HERCULES intercepted a higher performing CORPORAL missile in June 1960 and then another HERCULES. The Army deployed the NIKE HERCULES as an Anti-Tactical Ballistic Missile to Germany in the early 1960s. Meanwhile, DoD cancelled FABMDS in late 1962. In October the Army renamed the project AAADS-70 which became known as SAM-D.[18]

In March 1955 the Army gave Bell Labs a contract to study future (1960-70) threats presented by air breathing vehicles and ballistic missiles. In short order the Army began to focus on the latter problem, specifically the intercontinental ballistic missile. This led to a proposal for a new defensive missile, the NIKE II. The Army briefed this defensive scheme to the Assistant Secretary of Defense for Research and Development in March 1956. To handle both the air breathing and ballistic missile threats, the missile was to have interchangeable noses, one with an active sensor for use against air breathers and the other a jet-control device (thrust vector motor). The latter would enable interception of ballistic missiles by permitting maneuver after the warhead detached from the booster above 120,000 feet where aerodynamic controls surfaces were ineffective. The defense system would use two sets of radars: one considerably distant from the missile site and the other more closely located.[19]

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[15] Anti-ballistic missile (ABM) terminology can be confusing. Until the mid-1970s the term ABM was used, and I will confirm with that practice. I have used the term ballistic missile defense (BMD) to cover both tactical and theater (short range) and strategic (long range) defense. More recently theater ballistic missile (TBM) and theater defense has been used to indicate shorter range defense, while national missile defense (NMD) has been used to describe defense of the US homeland against ballistic missiles.

[16] Army Ordnance Missile Command, "SAM Reference Book," IV-16,V-1,2,3,6; John Bullard, "History of the Field Army Ballistic Missile Defense System Project, 1959-1962," Dec 1963, 5; Cagle, "Nike Hercules," 191; Woodrow Sigley, "Department of the Army Presentation to the Department of Defense Anti-Ballistic Missile Committee: Scheduling and Costs for the Army Anti-Ballistic Missile Program," Oct 1956, 4.

[17] The HAWK (homing all the way killer) was a SAM designed to down aircraft. It underscores the point that SAMs have an inherent capability to defense against ballistic missiles when mated with adequate computer, software, and radar.

[18] Bullard, "Field Army Ballistic Missile Defense," 2,4,9,12-13,80; Cagle, "Nike Hercules," 173,191,192n; Tony Cullen and Christopher Foss, eds., *Jane's Land-Based Air Defence, 1996-97* 9th edition (Coulsdon, Surrey, UK: Jane's, 1996), 290.

[19] "ABM Research and Development at Bell Laboratories: Project History," I-1, I-2,I-3,I-5,I-6,I-10, I-15; Walker, Martin, and Watkins, *Strategic Defense*, 10.

The Army and Air Force dueled for the ABM role, in what Bell Labs described as "intense rivalry."[20] In November 1956 Secretary of Defense Charles Wilson directed the Army to develop, procure, and man the land-based SAMs for point or terminal defense. This involved the missiles, site radars, and computers. Meanwhile the Air Force was to handle area defense that at this point meant long-range acquisition radars and the communications network that tied this system to the terminal defenses. This arrangement was endorsed by a 1957 committee report to the Deputy Secretary of Defense that reviewed the ballistic missile defense organization. In January 1958 the Secretary of Defense assigned the Army responsibility to develop all anti-ballistic missiles. The Air Force would go on to develop the system's long-distance radar acquisition system, the Ballistic Missile Early Warning System (BMEWS).[21]

By the end of 1957 the Army had a plan for the system's deployment. It involved 153 ABM batteries with an initial operational capability (IOC) of December 1961 with the full system operational in July 1967. In October 1958 the Army pushed for a deployment authority for this full-scale defense system. The plan called for deployment to begin in four years, at an estimated cost between $10 and $20 billion. This request was supported by the multi service, bi-national, North American Air Defense Command (NORAD). But initially at the Joint Chiefs of Staff (JCS) level, both the Air Force and Navy opposed production. The Army repeated its request in 1959, although by then the Army had cut the numbers to about 70 firing units and 3,600 missiles, the numbers sought during the early 1960s.[22]

In addition to the interservice opposition, a number of government agencies opposed deployment. These included the newly created Director of Defense Research and Engineering (DDR&E), the Comptroller, Bureau of the Budget, and a majority of the president's Scientific Advisory Committee on Ballistic Missile Defense. Objections to the BMD system were powerful, enunciated early, and have persisted over the past four decades. Most were technical. The opponents doubted that the ABM could sort out warheads, especially of small radar cross sections, from decoys or debris. There was also a question as to whether the system could defend against a massive, saturation attack. A further difficulty was the system's vulnerability to direct attack and to radar blackout caused by nuclear explosions. Another issue was that only components of the system could be tested, not the entire system.[23] And of course, there were concerns over cost.[24] (Other political and diplomatic objections would surface later.)

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[20] "ABM Project History," I-15.

[21] "ABM Project History," I-15; Space and Missile Defense Command, "A Discussion of Nike Zeus Decision," 5, SMDC; Ralph Taylor, "Space Counter Weapon Program: Air Defense Panel Presentation," Feb 1961 HRA K243.509-6.

[22] Army Ordnance Command, "SAM Reference Book," IV-4; North American Air Defense Command, "Quest for Nike Zeus and a Long-Range Interceptor," Historical Reference Paper No.6, 7-13 HRA K410.042-6.

[23] Testing of single units with test personnel at test sites trained and keyed up for action was considerably different than what might be expected from military units on routine duty, probably facing mass attacks. A similar criticism can be made of both American and Russian ICBM testing that has never been conducted along the planned flight paths across the North Pole, where severe magnetic abnormalities exist.

In short order the Air Force became one of the opponents of ABM development. While critics and cynics might see the Air Force as being a "poor sport" in taking this position after losing the ABM mission, that service's focus on offensive over the defensive was closer to its traditional view that reaches back to the Air Corps Tactical School in the 1930s, and bomber exploits over both Germany and Japan in World War II. For the moment, the USAF was out of the ABM business.[25]

Support for an ABM came mainly from three sources; the Army, defense contractors, and Congress. Army funding suffered in the 1950s era of nuclear weapons dominated by the Air Force, that was soon to be joined by a nuclear powered and nuclear armed Navy. The Army sought a larger piece of the military budget, at this point nuclear weapons seemed to be the way to gain access to these funds, and ballistic missile defense the surest path to that end. Industry saw a great opportunity. While some congressmen genuinely thought in terms of defense capabilities, others were surely influenced by the economics of the ABM: jobs for constituents. Key Senate leaders favored deployment. So despite the many persuasive arguments against the system by numerous authorities, in 1959 Congress appropriated pre-production funds.[26] The Executive Branch of government had other ideas.

The buildup that had began during the Korean War, tapered off under the frugal hand of President Dwight Eisenhower in the late 1950s. This arms buildup could probably only have been arrested by the prestige of this World War II hero and father figure. Despite the shock of the Sputnik launch in October 1957, the next year Ike rejected the ABM proposal as he slashed military spending in a massive economy effort. But industry countered with an effective campaign that forced the administration to continue ABM research efforts.[27]

Meanwhile in February 1957, the Army pressed forward by selecting Western Electric as the prime contractor for an anti-ICBM missile now called NIKE ZEUS. The next January, the National Security Council assigned the project the highest national priority.[28] The NIKE ZEUS was a better performing missile than the NIKE HERCULES. Consisting of three stages, rather than the two stages of the AJAX and HERCULES, it was larger and had a maximum velocity three times that of the latter missile.[29] The ZEUS missile demonstrated technical progress. In short order the Army found the testing

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[24] "ABM Project History," I-5,I-32; K. Scott McMahon, *Pursuit of the Shield: The U.S. Quest for Limited Ballistic Missile Defense* (Landham, MD: University Press of America, 1997), 15; SMDC, "Discussion of Nike Zeus Decisions," 5-7; Walker, Martin, and Watkins, *Strategic Defense*, 18.

[25] Daniel Papp, "From Project Thumper to SDI: The Role of Ballistic Missile Defense in US Security Policy," *Air Power Journal* (Apr 1987), 41.

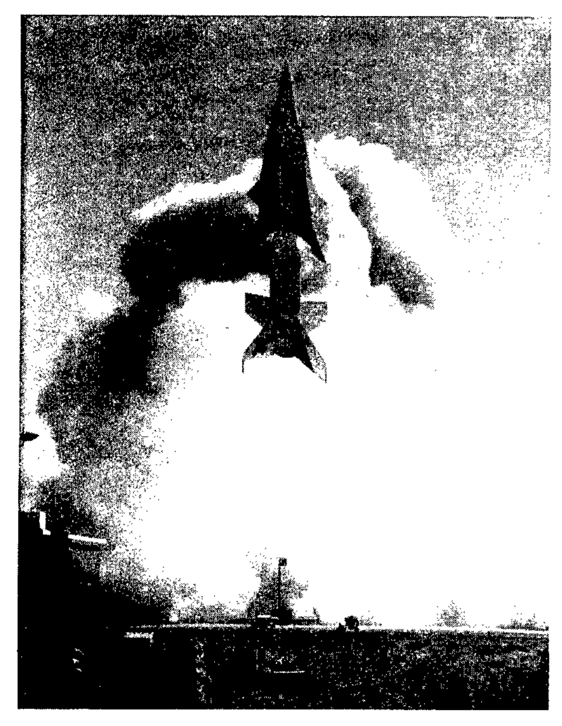
[26] Briggs, *Shield of Faith*, 141; Edward Jayne, "The ABM Debate: Strategic Defense and National Security," PhD Political Science, MIT, 1969, 24; NORAD, "NORAD's Quest for Nike Zeus," 2; Walker, Martin, and Watkins, *Strategic Defense*, 18.

[27] For example the Eisenhower Administration cut the planned interceptor fighter buy from 4,500 aircraft to 1,000, and the planned buy of 8,300 NIKE HERCULES to 2,400. Briggs, *Shield of Faith*, 137,141; Edward Reiss, *The Strategic Defense Initiative* (NY: Cambridge University, 1992), 22.

[28] "ABM Project History," I-15; NORAD, "NORAD's Quest for NIKE ZEUS," 1.

[29] Army Ordnance Missile Command, "SAM Reference Book," I-7,II-9,IV-14; "ABM Project History," I-22,1-23.

grounds at White Sands, NM, inadequate because of safety considerations. It then set up at the Navy's Point Mugu facility in California, but again found the safety restrictions unacceptable. Efforts to set up tests in the Atlantic Missile Range failed due to British objections in 1958. Thus, the Army went to the distant Kwajalein atoll, 4,800 miles from the United States, a move approved in February 1959. From this location the ABM's radar and missile could be operated and tested against ICBMs fired from the USAF's Vandenberg Air Force Base in southern California.[30]



NIKE-ZEUS in tests in February 1960. It became the basis of the US anti-ballistic missile program. Credit: US Army via Air University Press

The Army subjected the NIKE ZEUS to a through testing program, firing 69 missiles, the first in August 1959. In December 1961 the ABM intercepted a ballistic missile over the White Sands range. To clarify, the missile was designed to carry a nuclear warhead that had a lethal radius measured in hundreds of feet (unspecified in the unclassified sources). These warheads were not carried in the missile tests, therefore "successful" interceptions was judged on getting the NIKE ZEUS within the warhead's lethal radius of the target. After repeating this successful intercept, the operation moved to Kwajalein. The first test against an Atlas D ICBM in June 1962 failed because either the radars (according to the Army) or missile (according to the Air Force) malfunctioned. The Army considered the second test in July also as a failure, missing by more than a mile, a missile failure according to the Army, radar tracking the reentering fuel tank according to the USAF. But on 12 December 1962 the ZEUS came within the lethal radius of the proposed warhead, and then on the 22nd, even closer, within 200 meters. Nine further tests against Atlas and Titan missiles between March and December 1963 also went very well, with two assessed as partial successes, and the last seven as successes. Overall, then, the Army considered nine of the thirteen tests against the ICBMs successful.[31]

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[30] "ABM Project History," I-21,I-22; Army Ordnance Command, "SAM Reference Book," IV-12; Walker, Martin, and Watkins, *Strategic Defense*, 15.

[31] "ABM Project History," I-26,1-24; History of the 1st Strategic Aerospace Division: The Nike–Zeus Program, Aug 1959-Apr 1963, 17-18,29 HRA K-Div-1-Hi; Walker, Martin, and Watkins, *Strategic Defense*,19.

As with most missiles, the ZEUS encountered problems. But using the experience gained in other missile programs, these were manageable. One of the most serious was fires that burned through control rods holding fins causing "catastrophic failure." At first the engineers suspected hydraulic oil fires, but through trial and error the cause was found to be aerodynamic heating that severed the control fins. These were redesigned and fitted with teflon which solved the problem. Throughout, the missile encountered much greater problems involving the radar detecting the incoming target and discriminating between it, decoys, and debris, and with the electronics properly guiding the interceptor.[32]

In 1961 the outgoing Eisenhower Administration passed the promising but questionable ABM program onto the incoming administration of John Kennedy. The new president was caught in a thicket of problems: the budget crunch, the desire to expand non-nuclear war capabilities, as well as the growing strength of the Soviets (not to mention Kennedy's campaign issue of the "missile gap"). The new Secretary of Defense, Robert McNamara, studied the ABM program and in April concluded that it was neither technically feasible nor cost effective. In brief, he did not believe that the system could handle either a massive attack or decoys, but instead believed that the $15 billion program would only prompt the Soviets to build more ballistic missiles. Despite these misgivings, McNamara did allow about a quarter of billion dollars in research and development money.[33]

A few months later in 1961, following presentations by the contractor, the Secretary of Defense requested estimates of money and time for an ABM production program. In September he approved the first of a three phase program, the initial phase of which would protect six cities with twelve batteries with just under 1,200 missiles for a cost of about $3 billion. McNamara briefed Kennedy on the proposal in November, and it received his tentative approval. But budget talks in December 1961 convinced the president to forgo this interim deployment and instead push onto the next level.[34] This apparently was not made clear to the Army, as in August 1962 they again proposed deployment. The president's Scientific Advisory Council recommended against such action in October 1962, instead favored the development of a more advanced ABM system.[35]

The April 1961 DoD report that influenced McNamara did point out a possible technical solution for the ABM's major problems. American engineers developed two technologies that promised to overcome the technical difficulties that doomed NIKE-ZEUS (penetration aids and sheer numbers): the phased array radar and a new high-acceleration missile. This new radar, and layered defense provided by the two missiles

[32] "ABM Project History," I-22, I-23

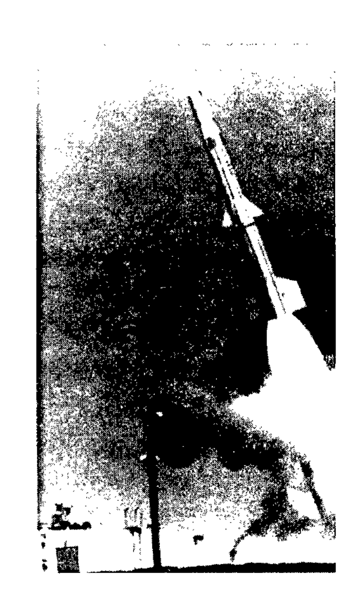
[33] Walker, Martin, and Watkins, *Strategic Defense*, 19. McNamara's position on the limits of the ABM system remained constant. The Kennedy Administration had pushed through a civil defense shelter program request in August 1961, but had difficulties with follow up programs the next year. One DoD study in the early 1960s concluded that shelters could save a life for $20 versus $700 per person for the NIKE-X. Briggs, *Shield of Faith*, 252; Jayne, "ABM Debate," 182,230.

[34] "Discussion of Nike-Zeus Decisions," 10 SMDC; "NORAD Quest for Nike Zeus," 16-17.

[35] "Discussion of Nike-Zeus Decisions," 11.

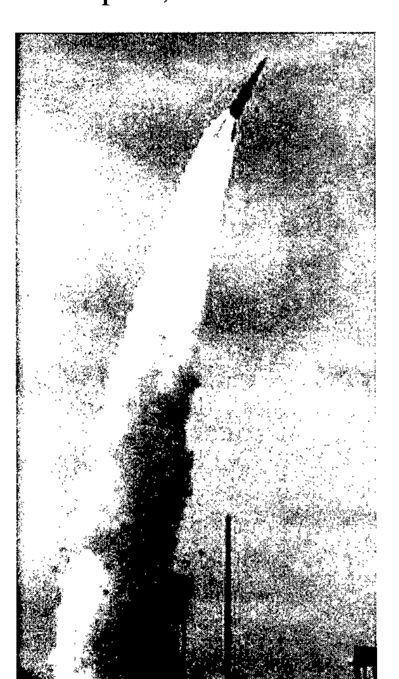
(the new short range, high acceleration missile and the older, long range missile), were the basis for the NIKE X.[36] McNamara issued the order directing development of the newer missile system in January 1963.

Called NIKE X (February 1964), the system would build on the existing program employing the Zeus missile as the long range interceptor missile.[37] This missile, renamed Spartan in January 1967, was to intercept incoming missiles at ranges of about 300nm and altitudes of 100nm. The major differences between the earlier NIKE ZEUS missile and later missiles were in the second stage. The first Spartan was test flown in March 1968. The Army test fired 20 missiles during the course of the test program, which terminated in June 1973, and another five production missiles during the Product Assurance Verification Test program.[38]



The SPARTAN was the long range missile in the Sentinel, later Safeguard, system. Credit: US Army Aviation and Missile Command

A new, high-acceleration missile for close in defense, the Sprint, was an effort to solve the problem of discrimination that dogged the NIKE ZEUS. It would use the atmosphere to sort out the warhead from decoys and debris, as these would decelerate at different rates of speed. The shorter range missile would intercept the target between 5,000 and 100,000 feet, usually at 40,000 feet, at a maximum range of 100 nm. High acceleration was just that; the Sprint pulled 100 "g"s. The Army let a study contract for the missile in October 1962 and then in March 1963 awarded Martin Marietta the contract for deployment of the missile in 1970. The missile first flew in November 1965 and then underwent flight testing in 1965-1970, during which 42 Sprints were flight tested with results significantly better than the requirements. Unlike most missiles that are long and thin in appearance, shaped like a pen, the Sprint was cone shaped with a base diameter of 4.4 feet and a length of 27 feet.[39]



The SPRINT was a high acceleration missile designed to provide a lower and second layer of defense for the Sentinel/Safeguard. Credit: Air Defense Artillery Journal

[36] "Discussion of Nike-Zeus Decisions," 8-9.

[37] "ABM Project History," I-36,I-37; Walker, Martin, and Watkins, *Strategic Defense*, 23.

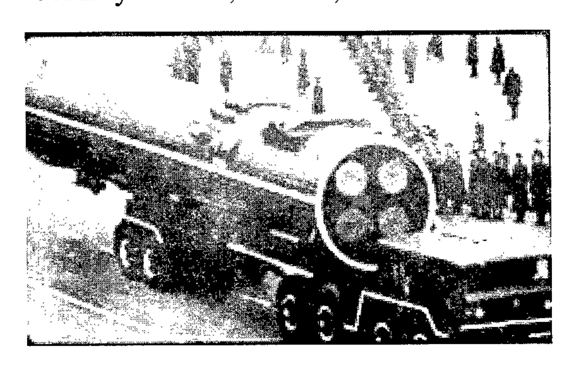
[38] "ABM Project History," 2-9,10-1.

[39] This compares with the NIKE ZEUS that was 44 feet long with a first stage base diameter of 45 inches and second and third stage diameter of 36 inches. Army Ordnance Missile Command, Reference Book, IV-14. "ABM Project History," I-37,2-9,9-1,9-4,9-21,9-23; Briggs, *Shield of Faith*, 246-47.

Phased Array Radar (PAR) was the system's other innovation. It used electronic scanning rather than mechanical scanning. PAR could handle many more objects and serve more than one function at the same time, whereas the NIKE-ZEUS radars could only track one target and one interceptor missile at a time. Another advantage of this radar was that it operated in the ultrahigh frequency (UHF) spectrum and was more resistant to nuclear blackout than the previous radar that was in the very high frequency (VHF) spectrum. This system also had greater power and thus greater range. The Army awarded the radar contract to Raytheon in December 1963.[40]

New Directions

As the system made technical progress, the rationale for the ABM system expanded in the early and mid-1960s in two different directions. The first was to provide protection for US strategic forces, which the military began to study in the 1963-64 timeframe. Specifically, in November 1965 the US began to study the defense of hardened ICBM sites.[41] The other effort that began in February 1965 was to look at the problem of Nth country threats, that is, nuclear-armed missiles possessed by countries other than the Soviet Union. At this point, the major country of interest was the People's Republic of China that had detonated a nuclear device in October 1964 and test fired an ICBM in October 1966. These two objectives merged in the December 1966 Plan I-67 that identified the Chinese as a potential nuclear missile threat and also focused on ABM defense of US land-based missiles.



Soviet Galosh, one of a number of Russian anti-ballistic missile systems. Under the terms of the 1972 ABM Treaty the Russians still maintain a BMD system defending Moscow. Credit: DoD

The Soviets prodded the US system with their ABM efforts. In July 1962, for example, Nikita Khruschev boasted that the Soviets could hit a fly in space. The first missile to attract western attention with the possibility of ABM capability, and the missile Khruschev was referring to, was codenamed GRIFFON. It resembled an enlarged SA-2 (the SAM missile type that had downed American U-2s over Russia and Cuba, and the only large missile used by the communists in the Vietnam War). It began flight tests in 1957 and reportedly achieved an intercept of a ballistic missile in March 1961. It was deployed outside Leningrad in 1960 and within two years the Soviets had built 30 firing sites. Then in 1963 the work around Leningrad stopped, and by the end of 1964 these sites were abandoned.[42]

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[40] "ABM Project History," I-37,I-44,2-1; Baucom, *Origins of SDI*, 19; Walker, Martin, and Watkins, *Strategic Defense*, 23,26.

[41] Other methods to enhance survivability of offensive forces were to launch on warning, dispersal, proliferation, and increasing weapons on alert.

[42] GRIFFON is frequently confused with the SA-5 GAMMON. Steven Zaloga, *Soviet Air Defence Missiles: Design, Development and Tactics* (Coulsdon, Surrey, UK: Jane's, 1989), 14,99-100,121-22; "RZ-25 Anti-Ballistic Missile System," 1 wonderland.org.nz/rz-25.htm.

The Soviets began work on a successor to the GRIFFON in the mid-1950s. Codenamed GALOSH (ABM-1) by North Atlantic Treaty Organization (NATO), it was a much larger missile than the GRIFFON, in fact larger than the ICBMs it was intended to intercept outside the atmosphere. Western intelligence first detected it in early 1964. Two years later the Soviets deployed 64 of the nuclear armed missiles in four sites in a ring about 40-50 miles from the center of Moscow. The US believed it was similar to the NIKE ZEUS, but not as capable, and as it could only engage a limited number of ICBMs and was vulnerable to nuclear blackout, therefore GALOSH was not of great concern. It achieved IOC in 1968 and was fully operational in 1970.[43]

About the same time (1963-64) US intelligence detected the construction in northwestern Russia, near Tallinn Estonia, of another potential ABM site, that came to be called Tallinn. The Defense Intelligence Agency thought this system had ABM capabilities, although there were those in both the military and Central Intelligence Agency who believed it was an anti-bomber defense system. If it did have ABM capabilities, these were marginal and only against earlier missiles. The SA-5 (GAMMON) was first flight tested in 1962, but did not become operational until 1968. By the early 1980s the Soviets deployed over 2,000 launchers at 120 sites.[44]

In any event, it was clear that the Soviets were making a much greater effort in the ABM field than the US. There are two possible, but contrasting, explanations for this situation. A benign view is that this interest was due to the traditional Russian defensive mindedness, or their horrific experience in World War II, or both. A more ominous explanation is that the Soviets were trying to obtain strategic nuclear superiority. In any case, it was believed that the Soviets had invested $4 to 5 billion in ABM by 1967 compared to about $2 billion by the US. In 1967 Secretary of Defense McNamara estimated the Soviets were spending 2.5 times as much as the US on air defense, while two years later Secretary of Defense Melvin Laird put that figure at 3.5 to 4 times.[45]

Opponents focused on three major aspects of the ABM. In the early 1960s these critics raised the issue of the adverse impact of a successful ABM system on the system

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[43] GALOSH carried a nuclear warhead of 2-3 megaton yield out to a maximum range of 300km and to a maximum altitude of 300 km. The three stage liquid-fuel rocket weighted 36.6 tons at launch. David Yost, *Soviet Ballistic Missiles and the Western Alliance* (Cambridge, MA: Harvard University, 1988), 28; Zaloga, *Soviet Air Defence Missiles*, 128,133,135,137.

[44] According to a high placed official and creditable academic, the majority of the intelligence community believed Tallinn was an air defense system. As noted above, SAMs have a latent BMD capability. Morton Halperin, *The Decision to Deploy the ABM: Bureaucratic and Domestic Politics in the Johnson Administration* (Washington: Brookings, 1973), 82; "ABM Project History," I-41,I-43,I-44,2-4; Briggs, *Shield of Faith*, 277; David Grogan, "Power Play: Theater Ballistic Missile Defense, National Ballistic Missile Defense and the ABM Treaty," Master of Laws, George Washington University Law School, May 1998, 9; Jayne, "ABM Debate," 307,318; Benjamin Lambeth, "Soviet Perspectives on the SDI," 50 in Samuel Wells and Robert Litwak, eds., *Strategic Defenses and Soviet-American Relations* (Cambridge, MA: Ballinger, 1987); Kerry Stryker, "A Bureaucratic Politics Examination of U.S. Strategic Policy Making: A Case Study of the ABM," MA thesis, San Diego State University, 1979, 107,156; Walker, Martin, and Watkins, *Strategic Defense*, 29-30; Zaloga, *Soviet Air Defence Missiles*, 15,100,102,123.

[45] Douglas Johnson, "Ballistic Missile Defense: Panacea or Pandora?," PhD dissertation, Harvard, 1982, 195; Yost, *Soviet Ballistic Missile Defense*, 26.

of deterrence, Mutual Assured Destruction (MAD).[46] The fear was that a ABM defense would lead to an arms race (of both defensive and offensive weapons) that would destabilize the international balance of power (terror). Cost was always a factor. While some used figures as "low" as $4-5 billion, others saw much higher costs for a complete system. For example, a shelter (Civil Defense) program alone would cost about $5 billion. Therefore the costs ranged between $4 billion for a thin ABM system with perhaps $40 billion over ten years for a more complete one. McNamara believed that since deployment of the ABM would only lead to the deployment of more ICBMs that would nullify the defense, both sides would only spend a lot of money for nothing.[47]

In the end, however, the major objection to the deployment of an ABM system was technical: there were continuing and serious questions as to whether or not the system could deliver on its promise. Would the system work against a mass attack, work the first time it was needed, and especially work against sophisticated threats that included decoys and jammers?[48]

There was a wide range of opponents to the system, both inside and outside the government. Scientists were most prominent and most effective. Especially telling, was a critical October 1964 article written by Herbert York, Deputy DDR&E and Jerome Wiesner of the president's Scientific Advisory Committee that appeared in the prestigious journal, *Scientific American.* Two of the most famous of the opponents were Cyrus Vance, Deputy Secretary of Defense, and his boss, Secretary of Defense, McNamara.[49] In January 1967 McNamara brought seven former and present special assistants to the president on science and technology to met President Johnson and voice their strong objections to the deployment of an ABM system. McNamara's concerns centered on the ABM cost and what it might encourage (or force) the Soviets to do. He was consistent in his position, and tied the ABM to a nation-wide shelter program that was unpopular with both the public and politicians, as well as expensive.[50] McNamara instead supported a strategy built around MAD.[51]

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[46] This very apt acronym described the theory that there was strategic stability if both major powers had the ability to survive a first strike and retaliate with overwhelming nuclear force.

[47] Interview with Lt Gen Austin Betts, 12 Mar 1971, 8 HRA K171.051-13; Briggs, *Shield of Faith,* 259; Donald Bussey, "Deployment of Anti-Ballistic Missile (ABM): The Pros and Cons," Library of Congress Legislative Reference Service, Apr 1967,17,24; Halperin, *Decision to Deploy the ABM,* 63;Walker, Martin, and Watkins, *Strategic Defense,* 26.

[48] See Jayne, "ABM Debate,"129-31 for example.

[49] Vance was a prominent and consistent opponent of the Vietnam War within the government. Later as Secretary of State in the Carter Administration, he resigned in protest over the attempted rescue of Americans held captive in Teheran.

[50] McNamara's predecessor, Thomas Gates was also against deployment because of the required civil defense shelter program that he believed the public would not support. Jayne, "ABM Debate," 90; Howard Stoffer, "Congressional Defense Policy-Making and the Arms Control Community: The Case of the Anti-Ballistic Missile," PhD dissertation, Columbia University, 1980, 117.

[51] The arguments for and against the ABM during this period are most clearly set out in Halperin, *Decision to Deploy the ABM,* 79-81. Baucom, *Origins of SDI,* 23; Betts Interview, 4; Stryker, "Bureaucratic Politics," 104; Briggs, *Shield of Faith,* 285; Walker, Martin, and Watkins, *Strategic Defense,* 29-30.

At the same time, there were increasing pressures to build the system. For years McNamara had brilliantly used interservice rivalry to have his way. But by 1965 the JCS put aside their bickering to unite behind a number of core programs. One of these issues was the Army's ABM. Within the administration, there were conflicting voices. The Secretary of the Air Force (Harold Brown) and Secretary of the Navy (Paul Nitze) favored some sort of deployment, while the Secretary of the Army's (Stanley Resor) position was unclear. DoD Systems Analysis opposed a growth in offensive systems, and instead supported ABM defense for silo–based Minuteman ICBM missiles. And while both the Advanced Research Projects Agency (ARPA) and DDR&E opposed deploying a NIKE-X system, they both were "quite enthusiastic" about an ABM system oriented against a smaller ICBM threat. Secretary of State Dean Rusk opposed ABM deployment. There were also political pressures from Congress, and not only from Republicans. President Johnson feared that failure to deploy the system could generate a potential "ABM Gap" that would be used by the Republicans in the upcoming election, just as the Democrats had effectively used the proported "missile gap" in the 1960 election. There were a number of strong ABM advocates in Congress, including a number of key senators. Johnson also feared that the military (specifically the JCS), unhappy about the conduct of the Vietnam War, would cause him political woes. At this point the public, as is so often the case, was uninformed and uninterested in the issue. In fact a 1965 public opinion poll in Chicago revealed that 80 percent of the respondents thought the US already had an ABM system in place![52]

The Johnson Administration attempted to fend off proponent's pressures by continuing development by asking for funds to procure long-lead items on one hand, while negotiating a treaty with the Soviets on the other. McNamara sold the president on this strategy in late 1966. LBJ favored arms control as he preferred spending on his beloved "Great Society" domestic programs, rather then on what many believed would be an unproductive if not provocative arms race. But the Soviets were not interested. In June 1967 President Johnson meet with Soviet Premier Alexi Kosygin at Glassboro, NJ and discussed an arrangement to curtail ABM deployment. McNamara told the Russians that limitations on defensive weapons were necessary to avoid an arms race. To this the Soviet leader, according to McNamara, grew red in the face, pounded the table, and angrily replied: "Defense is moral, offense is immoral!"[53] Pressure on the administration mounted when shortly thereafter the Chinese announced they had detonated a hydrogen bomb. Only a few days after Glassboro, Johnson told McNamara that he would approve deployment of an ABM system.[54]

In September 1967 McNamara delivered a key speech in San Francisco. He made clear that a ABM defense against a Soviet ICBM attack was both futile and expensive. Nevertheless, the Secretary of Defense announced that the US would deploy a "light"

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[52] Betts Interview, 8; Halperin, *Decision to Deploy the ABM*, 78,83; Jayne, "ABM Debate," 309,359; Stryker, 'Bureaucratic Politics," 171,181-82,208,227; 90th Congress, 1st Session. Committee on Foreign Affairs, "Staff Memorandum on Current Status of the Anti-Ballistic Missile (ABM) Program," Mar 1967, 2.

[53] Baucom, *Origins of SDI*, 34,33; Halperin, *Decision to Deploy the ABM*, 84-86; Jayne, "ABM Debate," 360.

[54] Baucom, *Origins of SDI*, 34; Jayne, "ABM Debate," 372.

ABM system to protect the US from a Chinese attack. He went on to mention that this system could be modified to defend the Minuteman ICBMs from a Soviet attack.[55] Other purposes of the US ABM system were to protect US (Minuteman) ICBMs and the US against an ICBM that might be launched by accident.[56]

The system would consist of the Spartan area defense and Sprint terminal defense of 25 major cities. This would include six of the long range Phased Array Radars (PAR), 17 of the shorter range Missile Site Radar (MSR), 220 Spartan missiles, and 480 Sprint missiles. Both missiles would carry nuclear warheads. The system would be known as Sentinel and had an estimated cost of $4 to 5 billion.[57]

ABM supporters had won a significant victory and thought the way was now clear. But if politics played an important role in bringing this about, the politics of the times played a role in derailing, or at least deflecting, the ABM deployment. Unexpectedly citizen groups arose to oppose siting of the missiles in and around the major cities in which they lived. This was unexpected as public opinion polls revealed that 40 percent of those who expressed an opinion supported ABM deployment by a margin of almost two to one. The problem was the classic one of "not in my backyard." Stimulated by the activism and anti-establishment wave of the late 1960s, stirred up by the encouragement, leadership, and advice of numerous articulate, activist, and passionate scientists and academics, a protest movement upset the administration's and proponents' plans. Another factor was that intelligence agencies downgraded the threat of Chinese ICBMs to the US. This of course generated second thoughts in Congress, which already did not favor deployment.[58]

Meanwhile diplomatic efforts continued. The critical event apparently was a Senate vote (52-34) to continue support of the program in the spring of 1968. In July 1968 President Johnson announced that talks with the Soviets would begin in September, but this effort was delayed by the August 1968 Soviet invasion of Czechoslovakia.[59] This was the situation when a new administration came into office.

Proponents of ABM expected the incoming Republican administration to press forward with the ABM deployment. But Richard Nixon, the stereotype Cold Warrior was also a shrewd politician. Reacting to the popular discontent over the path Sentinel was taking, within weeks of taking office the new administration stopped the project. Nixon

[55] Casualty estimates for a small Chinese attack against the US were about 6 to 12 million without defenses, 3 to 6 million with terminal defenses, and zero to 2 million with terminal and area defenses. Jayne, "ABM Debate," 302; Halperin, *Decision to Deploy the ABM*, 89n27.

[56] Baucom, *Origins of SDI*, 35-37.

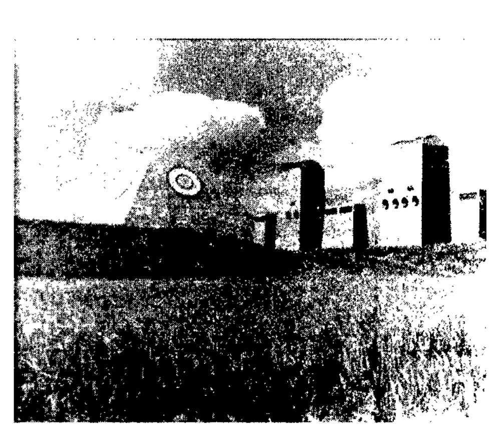
[57] Briggs, *Shield of Faith*, 286,327; Jayne, "ABM Debate," 249n38,374n2; Walker, Martin, and Watkins, *Strategic Defense*, 33.

[58] A United Press polling of senators in the spring of 1969 indicated 48 against and only 20 in favor of the system. James Bowman, "The 1969 ABM Debate," PhD dissertation University of Nebraska, Political Science, 1973, 127-32,170; McMahon, *Pursuit of the Shield*, 45,47; Stoffer, "Congressional Defense Policy Making," 149; Walker, Martin, and Watkins, *Strategic Defense*, 33.

[59] Jayne, "ABM Debate," 413-14; Thomas Longstreth and John Pike, *A Report on the Impact of U.S. and Soviet Ballistic Missile Defense Programs on the ABM Treaty* (n.p.: National Campaign to Save the ABM Treaty, 1984), 4; McMahon, *Pursuit of the Shield*, 45.

was presented with four options: to continue the ABM program as it was going, increase it to a "thick" system, change its orientation to a defense of Minuteman sites, or terminate the project. In March 1969 Nixon announced that the ABM system was being renamed (Safeguard), scaled down (from 17 Sprint sites to 12), relocated (away from the cities), and reoriented (to defend US ICBMs). This was not only a compromise position between the extremes of increase or cancellation, it also was a different path than that trod by the previous Democratic administration. For Nixon apparently saw the system as a bargaining chip in the ongoing arms negotiations.[60]

The public and political battle continued. Early 1969 saw one of the hottest discussions of defense policy seen in post World War II America. The public remained relatively uninformed or confused about the issue, but those who expressed an opinion continued to support ABM by a margin of nearly two to one. The Senate was a different matter. After a record 29 day Senate debate, on 6 August 1969 the Senate voted and divided evenly, allowing Vice President Spiro Agnew to cast the deciding vote to preserve the ABM system.[61]



Missile Site Radar (MSR) at the Grand Forks site. The tall structures on the right are cooling towers. Credit: US Army Space and Strategic Missile Command

Technical progress continued as did arms negotiations. The public discussion trailed off in a somewhat subdued manner and then the issue concluded in an unexpected manner. After difficult negotiations, seemingly between not only the US and Soviets, but between the executive and legislative branches, and within the administration, an agreement was reached. To the surprise of most who only saw Nixon as a hard line, Cold Warrior, the administration concluded two important arms control measures. In May 1972 the two superpowers signed the SALT (Strategic Arms Limitation Treaty) agreement that limited the numbers of strategic weapons.[62] More important to this story was the agreement to limit ABMs.

The ABM treaty, also concluded in May 1972, agreed that each country would be allowed to have two ABM sites. One was permitted within 150 km of the national capital, and a second, at least 1,300 km distant from the first and within 150 km of ICBM fields. Each site was limited to a maximum of 100 launchers, two large and 18 small radars, and 100 interceptor missiles. The Treaty prohibited developing, testing, and deploying systems or their components that are air, sea, or space-based; mobile; and upgrading

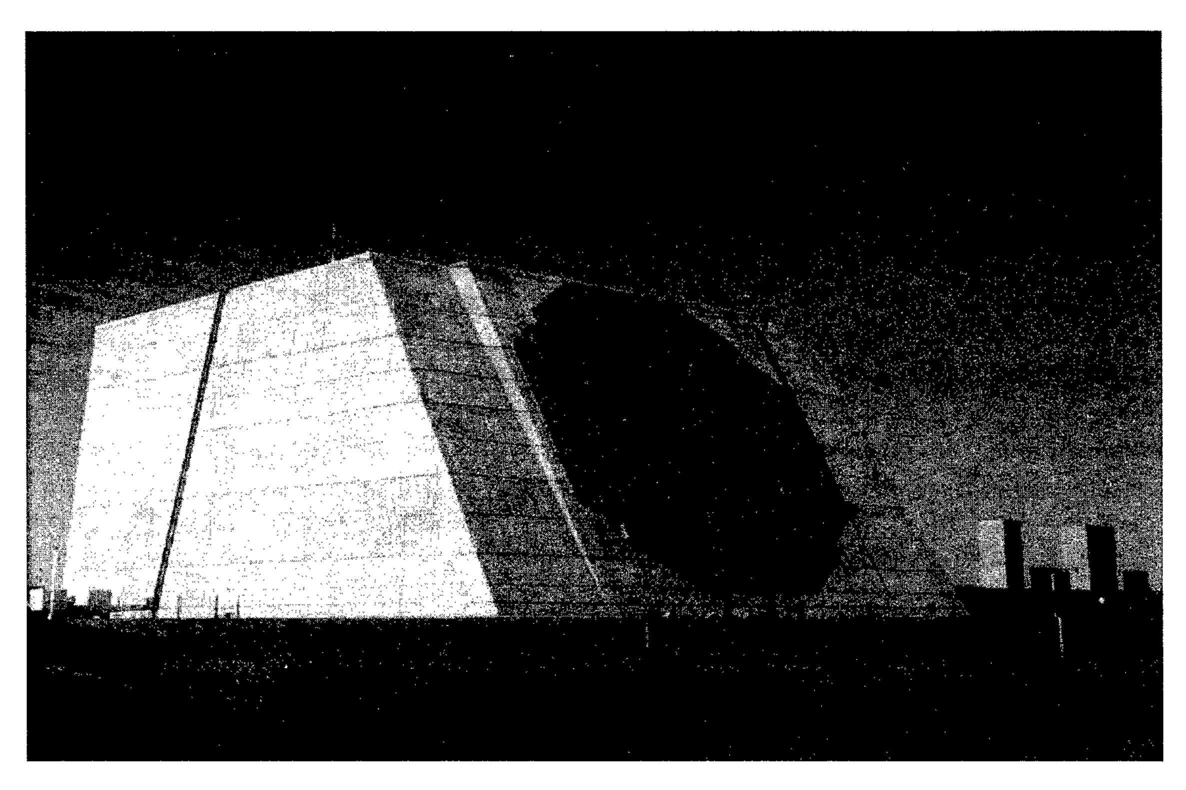
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[60] Baucom, *Origins of SDI*, 38; Bowman, "1969 ABM Debate," 178; Briggs, *Shield of Faith*, 299; Erik Pratt, "Weapons Sponsorship: Promoting Strategic Defense in the Nuclear Era," PhD dissertation, Political Science, University of California, Riverside, 1989, 148; Stryker," Bureaucratic Politics," 229; Walker, Martin, and Watkins, *Strategic Defense*, 33,38.

[61] Baucom, *Origins of SDI*, 43; Bowman, "1969 ABM Debate," 173,177.

[62] The SALT I agreement gave the Soviets a numerical edge with both ICBMs (1,618 to 1,054) and submarine launched strategic missiles (62 boats and 950 missiles to 44 boats and 710 missiles). Baucom, *Origins of SDI*, 51-71;Longstreth and Pike, *Report on the Impact*, 4.

existing system to ABM capabilities. It further forbid developing, testing, and deploying rapid reload launchers and multiple, independently guided warheads on the defensive missiles. While banning strategic defense and testing of missiles against strategic missiles, the treaty failed to define either "strategic" or "tactical" missiles. The Treaty could be revoked by giving six months notice. In 1974 the two countries amended the Treaty by reducing the permitted sites from two to one for each country. The Soviets chose to defend Moscow, the US to continue work on its Grand Forks, ND site.[63]



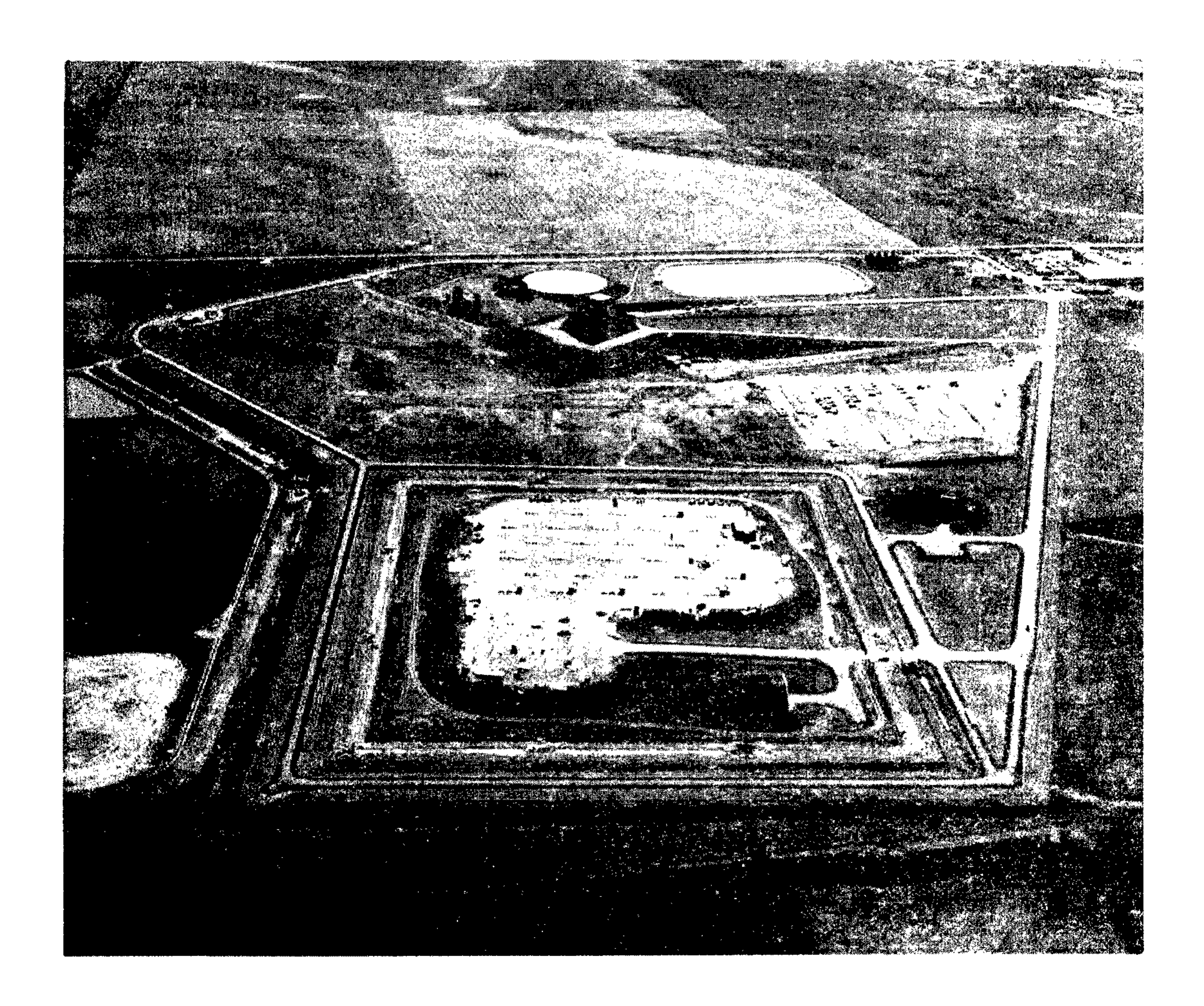
Perimeter Acquisition Radar (PAR) at the Grand Forks site. This radar provided long range warning and acquisition for the Spartan missile. Credit: US Army Space and Strategic Missile Command

The life of the US system was brief. The Air Force declared the installation at Grand Forks operational in September 1975. By this time the military decided that the system was too expensive and was of only dubious value. Therefore the next February the JCS ordered the site deactivated leaving the US without an active ABM system. Meanwhile the Soviets continued to operate their one system in the Moscow area as they do to this day.[64] The American ABM appeared dead. It would not come to life for another decade.

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[63] Baucom, *Origins of SDI*, 70; David Grogan, "Power Play: Theater Ballistic Missile Defense, National Ballistic Missile Defense and the ABM Treaty," Masters of Laws, George Washington University Law School, May 1998, 11; L. Maust, G.W. Goodman, and C.E. McLain, "History of Strategic Defense," SPC final report, SPC 742, Sep 1981, 16-17.

[64] The Soviets developed a follow-on missile for their ABM that fell within the allowable limits of the treaty. The ABM-X-3 GAZELLE was similar to the American Sprint. Walker, Martin, and Watkins, *Strategic Defense*, 38; Zaloga, *Soviet Air Defense Missiles*, 138-39.



Grand Forks site. The MSR is in the upper center. The pond beyond and to the left is a heat sink, the pond to the right is a water storage reservoir. The 16 round objects in front of the MSR are the silos for the Sprints and the longish ones between them and the MSR are the Spartans. Credit: US Army Space and Strategic Missile Command

Ballistic Missile Defense: 1976 to 1991

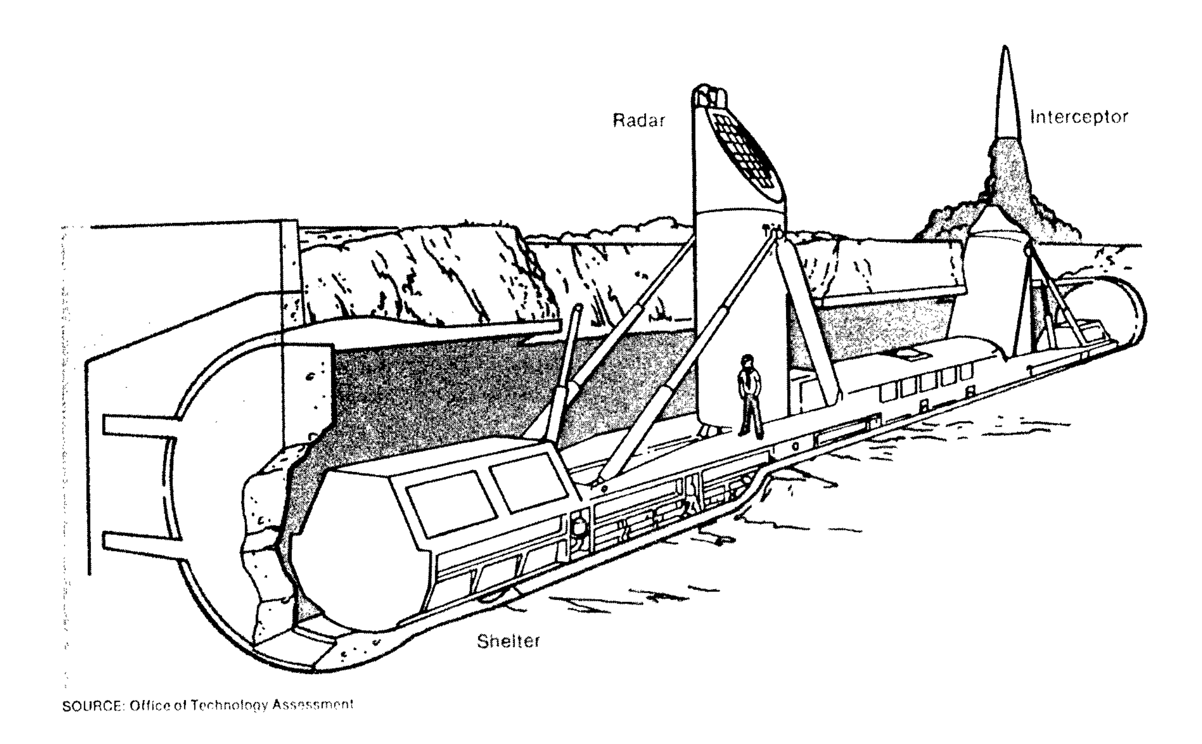
Ballistic missile defense continued after the demise of Safeguard, albeit on a reduced scale. In the words of one student of the events: "The conventional wisdom after Sentinel-Safeguard held fast—the deployment of nation wide ballistic missile defenses to counter a full-scale Soviet assault was strategically unsound, technically risky, and probably unaffordable....Only a watershed event could challenge the conventional wisdom."[65] In fact two major events impacted on ballistic missile defense in the two decades following the conclusion of the ABM (Anti-Ballistic Missile) Treaty: the Strategic Defense Initiative (SDI) and the Patriot-Scud duel in the Gulf War.

Until these events ballistic missile defense took a backseat. One abortive effort was to connect ballistic missile defense (BMD) with the defense of Minuteman sites. This program had began in 1971 as Hardsite Defense, a prototype program aimed at exploiting new technology. It also attempted to adapt existing software and hardware to the task and thus field a system less expensive than Safeguard. Also called Site Defense, it was built around a modified Sprint (Sprint II that featured enhanced accuracy and maneuvering capability) and hardened silos. From this arose a proposed system the Army called LoAD (Low Altitude Defense) that was a high acceleration missile armed with a nuclear warhead like the Sprint, but was somewhat smaller. (The radar was about 1/10 the size of SAFEGUARD system and the missile ¼ the size of Sprint.) It came into view in association with the problem that both the Carter and Reagan administrations had with siting the MX (missile experimental) Intercontinental Ballistic Missile (ICBM), that was programmed to follow the Minuteman series. In 1981 the Office of Technology Assessment (OTA) published a study that examined eleven basing modes for the proposed new ICBM and concluded that five were feasible. One of these included BMD protection of a deceptive basing concept, sometimes called a "race track" system, but officially known as Multiple Protective Shelter (MPS). It would consist of 200 ICBMs, each missile shuttling between 23 shelters that would mainly house decoys along with the one ICBM. The operators would randomly move the missiles and decoys, so that an attacker would have to target all of the shelters in order to take out the strategic missiles.[66]

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[65] K. Scott McMahon, *Pursuit of the Shield: The U.S. Quest for Limited Ballistic Missile Defense* (Lanham, MD: University Press, 1997), 55.

[66] The Air Force opposed such a system, but in the interest of maintaining military solidarity, muted its views. Desmond Ball, "U.S. Strategic Concepts and Programs: The Historical Context," 25 in Samuel Wells and Robert Litwak, eds., *Strategic Defenses and Soviet-American Relations* (Cambridge, MA: Ballinger, 1987); Donald Baucom, *The Origins of SDI: 1944-1983* (Lawrence, KS: University Press of Kansas, 1992), 95,172-73; Douglas Johnston, "Ballistic Missile Defense: Panacea or Pandora?", PhD dissertation, Harvard, 1982, 54; Edward Reiss, *The Strategic Defense Initiative* (NY: Cambridge University, 1992), 24; Office of Technology Assessment, *MX Missile Basing* (Washington: GPO, [1981]), 3; James Walker, Frances Martin, and Sharon Watkins, *Strategic Defense: Four Decades of Progress* (n.p.: Historical Office, U.S. Army Space and Strategic Defense Command, 1995), 41.



The Low Altitude Defense System (LoADs) was to randomly shuttle around in a tunnel system to avoid detection. by an attacker. When necessary its radar and missile would burst through the tunnel ceiling to engage incoming Credit: Office of Technology Assessment

To protect MPS a mobile BMD was to be buried in a tunnel. The planners believed that such a system, one defensive unit per ICBM complex, could effectively double the number of missiles the attacker would have to use to insure he took out the ICBMs based in deceptive shelters. There were two major assumptions to the scheme. First, the location of both the MX and LoAD had to be uncertain to the attacker. Second, the BMD had to be hardened to survive close ("nearby") nuclear detonations. The study stated that this scheme could require modification or abrogation of the ABM treaty, because of LoAD's mobility. An October 1980 Army study estimated that it would cost $8.6 billion over ten years to defend the planned 4,600 shelter deployment. The study further noted that an alternative, BMD defense of a fixed silo ICBM deterrent force, would require cutting edge technology and thus was too risky to support a deployment decision. The MX basing caused considerable political uproar to a number of administrations, and spread confusion at the highest level.[67]

In 1983 President Ronald Reagan created a commission, chaired by retired USAF Lieutenant General Brent Scowcroft, to study the issues of intercontinental ballistic missile basing and updating of strategic forces. Their report in April 1983 called for "vigorous research" in BMD technologies but not deployment. It concluded that no present BMD technology appeared to combine "practicability, survivability, low cost and technical effectiveness sufficient to justify proceeding beyond the stage of technology development."[68] The Scowcroft report recommended passive defenses (hardened silos)

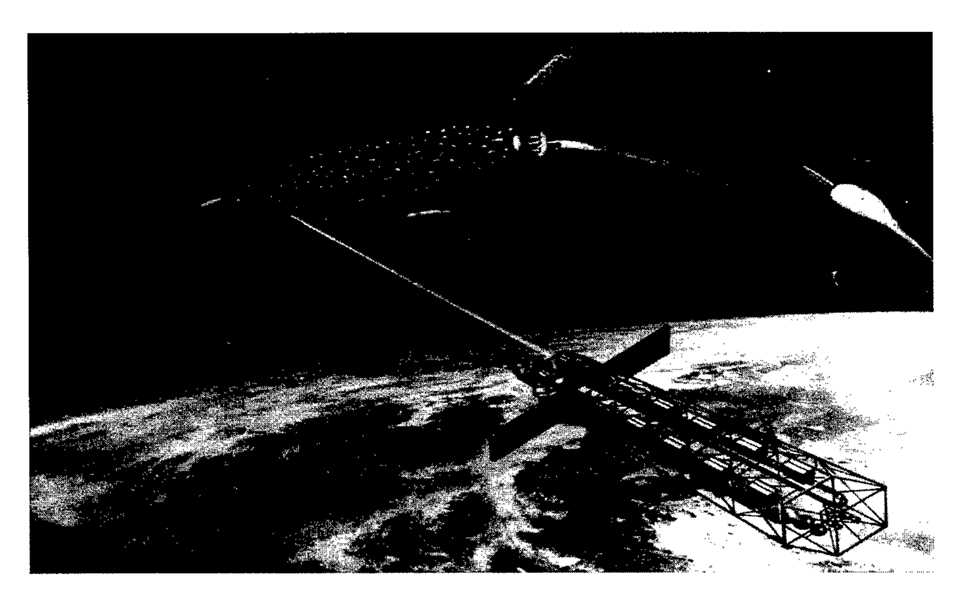
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[67] *Air Force Magazine* (May 1999), 150; OTA, *MX Missile Basing*, 5-6,17,125.
[68] Reiss, *Strategic Defense Initiative*, 56.

and a shift toward smaller, mobile missiles, the so-called "Midgetman." Partially as a result of this report the government cancelled the BMD system for MPS in 1984. The eventual US solution was to put the new missiles in silos that had housed Minuteman III missiles, without BMD protection.[69]

The Strategic Defense Initiative, a.k.a. Star Wars[70]

Clearly SDI was a watershed event in the history of the US BMD. On 23 March 1983 President Ronald Reagan delivered probably his most memorable speech and one of the country's more significant presidential speeches in a number of decades, certainly in defense matters. It forced a major rethinking of defense strategy and led to the expenditure of billions of dollars. SDI also proved to be a key weapon in the Cold War, especially in its startling conclusion. In brief, the President called for new strategic defense thinking and a shift from a policy of nuclear deterrence to one of defense. Unlike those who pushed for a diplomatic solution to the problems of nuclear weapons and super power rivalry, Reagan sought a different path, a technical solution. In his words, "Wouldn't it be better to save lives than to avenge them?" (Ironically, a phrase similar to Soviet Premier Alexi Kosygin's 1967 heated comment that defense was moral and offense was immoral.) He put forward a new vision based on American technical and industrial capabilities to render offensive nuclear weapons "impotent and obsolete." He



Artist's conception of the Strategic Defense Initiative (SDI) in action. This depicts a space platform using a laser to destroy warheads from a cluster of decoys. Credit: US Army Space and Strategic Missile Command

[69] The BMD system had been renamed SENTRY in 1982. Reiss, *Strategic Defense Initiative*, 57; Walker, Martin, and Watkins, *Strategic Defense*, 43.

[70] The key source on SDI is Baucom, *Origins of SDI.*

closed by stating, "My fellow Americans, tonight we're launching an effort which holds the promise of changing the course of human history. There will be risks, and results take time. But I believe we can do it."[71]

SDI appealed to Reagan as a way out of the "balance of terror," the system of nuclear deterrence that had been American policy for decades.[72] SDI was cheered by those who distrusted the movement toward arms control and feared or believed that these treaties and the unrelenting arms buildup gave the Soviets parity, if not superiority, in strategic weapons.[73] Some also suspected that the Russians would cheat and perhaps break out from the treaty to gain a significant military advantage over the US. A number of individuals and groups were responsible for and pushed this decision, Reagan's White House intimates, some Senators who favored laser weapons (led by Malcolm Wallop), a group that pushed space-based defenses that gathered under the name "High Frontier," and an influential conservative think tank (The Heritage Foundation). The system received only mixed support from the military as they feared that dollars to SDI would be taken from other programs.[74]

While Reagan saw SDI as giving the US a more moral defense policy than Mutual Assured Destruction (MAD), the tacitly agreed upon principle of the superpowers since the early 1960s, other proponents saw additional advantages. Certainly SDI would give the US more options and play to American technical and industrial strengths. The system would also serve as a counter to Soviet BMDs and heavy ICBMs, defend against both an accidental (or unauthorized) attack, and add uncertainty to an attacker's considerations. Finally, an American BMD would be insurance against the possibility of the Soviets breaking out of the ABM treaty.[75]

Opponents of BMD were taken by surprise and put on the defensive. They attempted to ridicule the system by naming it "Star Wars" after the popular, futuristic movie of the day. This negative tag was quickly picked up and circulated by the media, who mainly opposed SDI. There also was substantial opposition from both the Air Force and Navy. Of course the arms control community along with many in academia rose against the project. Again scientists were prominent in opposition. Close to 7,000 scientists pledged not to accept SDI money, including the majority in the physics departments at the top 20 colleges and 15 Nobel laureates. Their criticisms were perhaps

[71] Kerry Hunter, "The Reign of Fantasy: A Better Explanation for the Reagan Strategic Defense Initiative," PhD dissertation, University of Washington, 1989, 182-84, quotes respectively 183 and 184.

[72] Hunter, "Reign of Fantasy," 91-95,142.

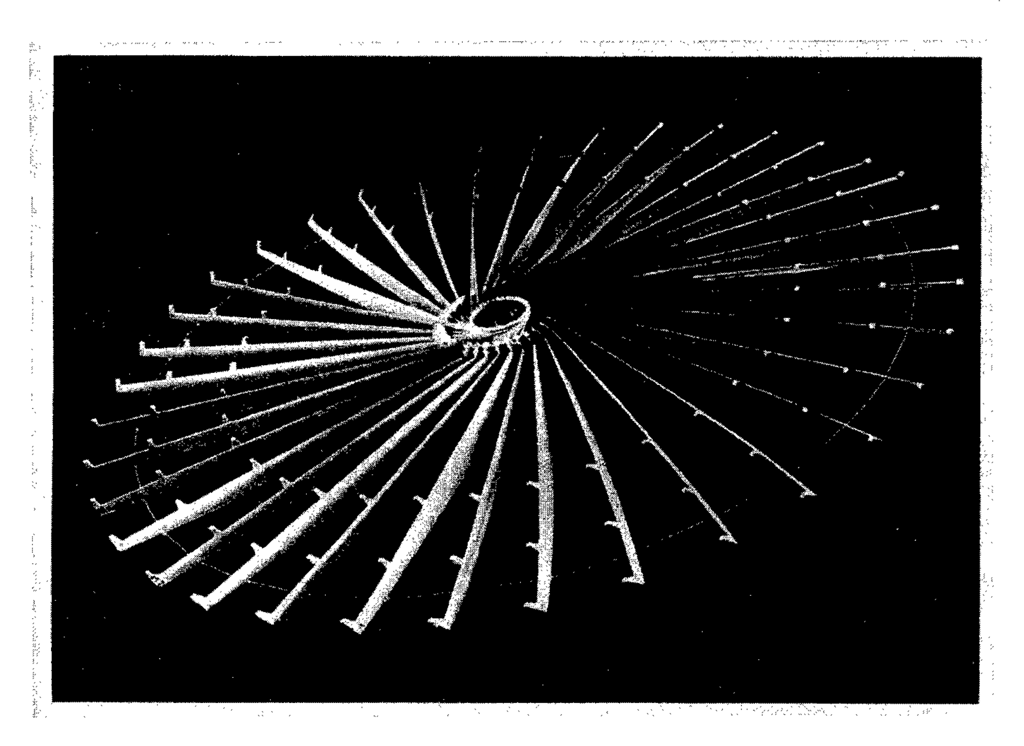
[73] The major US concern was that the Soviets could convert their advantage of heavier missile throwweight into many more maneuvering warheads and move toward strategic superiority. Baucom, *Origins of SDI*, 77-85.

[74] Baucom, *Origins of SDI*, 72; Reiss, *Strategic Defense Initiative*, 1,42-42,92.

[75] David Dennon, *Ballistic Missile Defense in the Post-Cold War Era* (Boulder, CO: Westview, 1995), 97; William Kincade, "The SDI and Arms Control," 102 in Wells and Litwak, *Strategic Defenses*; Roberto Zuazua, "The Strategic Defense Initiative: An Examination on the Impact of Constructing a Defensive System to Protect the United States from Nuclear Ballistic Missiles," MA thesis, Southwest Texas State University, 1988, 28.

best summarized by former President Jimmy Carter who called SDI "infeasible, extremely costly, misleading and an obstacle to nuclear arms control."[76]

The technical obstacles were truly enormous, as this project was well beyond the state-of-the-art. Americans are optimistic, however, and believe that if enough brainpower and money are focused on a problem, a solution can be found. But this comes at a cost, which was also enormous, uncertain, and disputed. The total bill was put in the range of hundreds of billions, with some going as high as $1 trillion.[77] The third major criticism of SDI was that it would unravel the various arms agreements (specifically violate the ABM Treaty) and lead to an arms race.[78] Opinion polls revealed a confused public. Many believed they were already protected by a BMD system, and their support or opposition was highly dependent on how the question was worded.[79]



The Homing Overlay Experiment (HOE) used a warhead that expanded to destroy incoming warheads. In June 1984 it successfully intercepted a non-nuclear reentry vehicle. Credit: US Army Space and Strategic Defense Command

While most of the technical progress in the 1980s came in the lab, there were field successes. One new area was a non-nuclear warhead, forced on the developers after the

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[76] Reiss, *Strategic Defense Initiative*, 2,89; Dennon, *Ballistic Missile Defense*, 90; Paul Uhlir, "The Reagan Administrations' Proposal to Build a Ballistic Missile Defense System in Space: Strategic, Political and Legal Implications," MA thesis in International Relations, University of San Diego, 1984, 101.

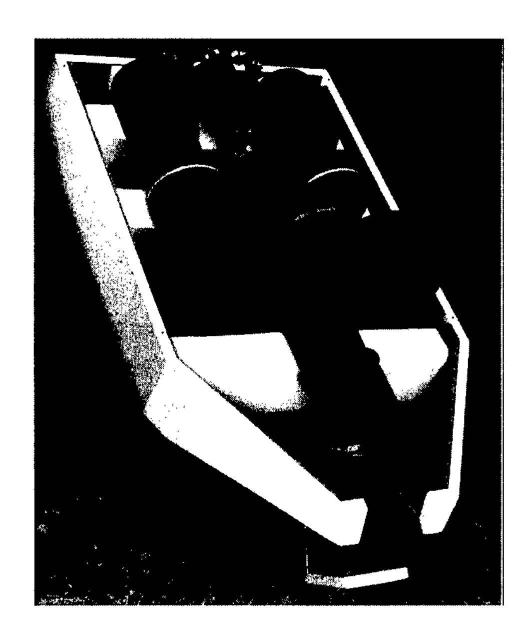
[77] Hugh Funderburg, "The Strategic Defense Initiative and ABM Efforts: An Analysis," MA Political Science, Western Illinois University, 1985, 17; Thomas Longstreth and John Pike, "A Report on the Impact of U.S. and Soviet Ballistic Missile Defense Programs on the ABM Treaty," National Campaign to Save the ABM Treaty, Jun 1984, 10; Reiss, *Strategic Defense Initiative*, 60; Zuazua, "Strategic Defense Initiative," 38.

[78] Kincade, "SDI and Arms Control," 103; Zuazua, "Strategic Defense Initiative," 38.

[79] Hunter, "Reign of Fantasy," 154-69.

demise of SAFEGUARD's nuclear warhead. Perhaps more impressive was the Homing Overlay Experiment (HOE) that in June 1984 successfully intercepted a Minuteman ICBM over 100 miles in altitude and traveling at upwards of 15,000mph. Although some critics claimed the tests were rigged, this certainly appeared to be an outstanding success.[80]

The SDI deployment plan evolved. The original concept called for 300 satellites, each carrying about 100 interceptors that would engage incoming ICBMs. This was sometimes called "battle stations" or "smart rocks." This plan changed to one of smaller interceptors that would independently engage targets, so-called "brilliant pebbles."[81] Paul Nitze, a supporter of BMD, raised the bar for deployment of such a system in a speech he delivered in February 1985. He called for the deployment of an BMD system only if it could meet three conditions: that it could defend against a full-scale Soviet attack, could survive a direct attack, and was cost effective at the margins. (That is, the cost of the last interceptor bought would be less than the last offensive missile bought.) The Nitze Criteria were seen as an obstacle to deployment of the system--some in fact saw this as an attempt to kill the project.[82]



The US later changed the SDI concept from a large space (or battle) station to smaller units that became known as "Brilliant Pebbles." Credit: US Army Space and Strategic Missile Command

One result of the US military buildup and the SDI program was to renew strategic arms negotiations between the Soviet Union and the United States. The two superpowers verbally agreed in meetings in Geneva in November 1985 to seek a 50 percent reduction in strategic weapons. Less than a year later at Reykjavik they discussed eliminating all ICBMs within ten years. The latter was rejected by Reagan, however, as it required the termination of SDI. The Reagan Administration altered the dynamic of the subject by changing US policy from a "narrow" or "strict" interpretation of the 1972 ABM Treaty to a "broad" or "loose" one. This change gave proponents of the system more latitude to push technical development, while stirring concerns in Congress and among American Allies.[83] But before the end of the decade the world was turned upside

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[80] Denoon, *Ballistic Missile Defense*, 13, 105n53; Aengus Dowley, "A Review of the Strategic Defense Initiative and Ballistic Missile Defenses," MS thesis, Southwest Missouri State University, 1995, 69,124; Funderburg, "Strategic Defense Initiative," 17; Daniel Papp, "From Project Thumper to SDI," *Air Power Journal* (Apr 1987); Zuazua, "Strategic Defense Initiative," 28.

[81] Denoon, *Ballistic Missile Defense*, 111; McMahon, *Pursuit of the Shield*, 7.

[82] Denoon, *Ballistic Missile Defense*, 21,151.

[83] Stuart Croft, "The United States and Ballistic Missile Defence: ABM and SDI," Council for Arms Control, 1987, 11,13-14; Reiss, *Strategic Defense Initiative*, 91.

down when the Soviet Union collapsed. Clearly major factors in this momentous event were the US arms buildup in general, and SDI in particular.

But the decline of the Soviets didn't end the BMD story. In a sense, it made it much more difficult. For the breakup of the Soviet Union led to the recognition of a new ballistic missile threat, not from a superpower that was deterred by offensive nuclear weapons, but by third world countries that might not be. The balance of terror between the two superpowers overshadowed the proliferation of both ballistic missiles and nuclear weapons. The demise of the bi-polar superpower system also meant the end of the control that the Soviets had over their clients. This threat from countries other than the Soviet Union became clearly visible for decision makers and the public alike in the 1990-91 Gulf War.

The Gulf War: Patriot versus Scud

Before discussing the BMD in action, it should be emphasized that the discussion thus far has been of strategic defense. That is to say, BMD development centered on homeland BMD against ICBMs that were armed with nuclear warheads primarily launched in mass. The end of the Cold War not only spread the geographic threat of missiles and weapons of mass destruction, but shifted the focus of BMD to include, if not concentrate on, shorter range ballistic missiles, referred to as theater defense. These ballistic missiles were not only shorter range, but not necessarily nuclear armed, as was the case in the Gulf War. In many respects the Iraqi use of Scud in the Gulf War against Israeli and Saudi cities resembled the World War II V-2 campaign. There was one important difference, however, the defender now had active, ground-based defenses along with active distant defenses.

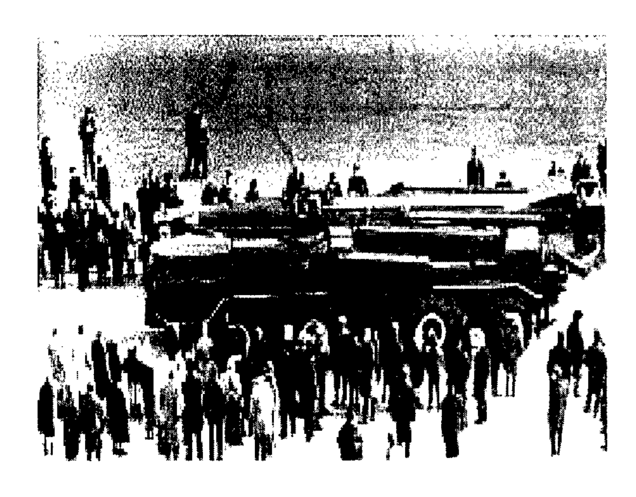
The Gulf War story is overwhelmingly one of Coalition military and technological success, with one notable exception: the campaign against Iraqi tactical ballistic missiles. Initially this aspect of the war looked to be a lopsided contest pitting Iraq's outdated missiles against the Coalition's overwhelmingly superior technology and complete air dominance. But this is not how events unfolded. Despite using nearly every type aircraft in the Coalition's considerable air fleet against the Scuds, in the words of one participant and student of this campaign, there was "scant evidence of success."[84] The Iraqis effectively used their Scuds to frustrate the Coalition, seize the initiative, and to apply great political and psychological pressure that had the potential to unravel the alliance. In this way, the Scud campaign was the high point for the Iraqis and low point for the Coalition airmen.

From the outset the reader should realize that the Gulf War was neither the first nor the largest ballistic missile war. These distinctions belong to the German V-2 missile campaign that rained destruction on Allied cities during World War II. The V-weapons campaign was much larger in numbers and much more destructive, albeit shorter in range, than the Iraqi missile offensive. However both campaigns had similar limitations

[84] Merrick Krause, "From Theater Missile Defense to Antimissile Offensive Action: A Near Strategic Approach," School of Advanced Airpower Studies thesis, Sep 1999, 15.

(poor accuracy and small conventional warheads) and were mainly political and psychological in their intent and impact. Forty-five years separated the two operations, but the severe problems, frustrations, and failures experienced by the Allies while defending against German missiles, despite expending tremendous resources, were similar to those encountered by Coalition airmen during the Gulf War. One major difference between the two campaigns was that in the more recent war is that the defenders had an active ground-based defense.

Scud is the North Atlantic Treaty Organization (NATO) code word for a Soviet surface-to-surface ballistic missile that evolved from the German V-2. It is little improved over the German missile, primarily having a longer range, somewhat better accuracy, but carrying a smaller payload. The Soviets tested the Scud A in April 1953 and deployed it in 1955. Scud B was an improved version that extended the missile's range from 180km to 300km, and enhanced its accuracy from 4,000 to 1,000 meters CEP but carried only half the 989kg warhead of the "A."[85] It was first launched in 1957. A key feature of this type missile was its mobility, made possible by its wheeled chassis that served as a transporter, erector, and launcher (TEL). In 1961 the Soviets began exporting the Scud A to their Warsaw allies and then in 1973 shipped the first Scud B to Egypt, and later to a number of other middle east countries, including Iraq.[86]



Soviet Scud on transporter. The Scud was a development of the V-2 that went on to equip not only Soviet bloc forces, but also a number of other countries as well. Credit: DVIC

The Scuds saw service in two Middle-East wars prior to the 1991 Gulf War. Both sides in the Iran-Iraq War used ballistic missiles to bombard each other's cities. Although figures vary, the Iraqis fired at least 190 at Iran that may have killed 2,000 Iranians.[87] During the 1980-96 Afghan War, pro-government forces fired 1,000 to 2,000 Scuds at the rebels. On one day, three missiles killed 300 people.[88]

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[85] CEP, circular error probable. The radius within which half the missiles will impact. Norman Freidman, *Desert Victory: The War for Kuwait* (Annapolis: Naval Institute, 1992), 340.

[86] Steven Zaloga, "The 'Scud' Ballistic Missile," *Asia Pacific Defense Review* (Nov/Dec 1993), 16-21.

[87] Gulf War Air Power Survey, vol.2, *Operations* (Washington: GPO, 1993), 180,n186; Warren Lenhart and Todd Masse, "Persian Gulf War: Iraqi Ballistic Missile System," CTS, Feb 1991, 2-3 AUL MU42953-1#91-173f; Bryon Greenwald, "Scud Alert: The History, Development and Military Significance of Ballistic Missiles on Tactical Organizations," Institute of Land Warfare, Oct 1995, 8 AUL MU42840-44#22. A fourth source writes that both sides fired 1,000 missiles. George Lewis, Steve Fetter, and Lisbeth Gronlund, "Casualties and Damage from Scud Attacks in the 1991 Gulf War," DSCS Working Paper, Mar 1993, n3.

At the outbreak of the Gulf War, intelligence estimated that the Iraqis had 400 to 600 Scuds. This was in error as the Iraqis later acknowledged buying 819 Scuds and secondary sources put the upper number in the range of 1,000 to 1,200.[89] The Iraqis modified the Scud B and extended its range to 650km. This conversion also increased missile speed 40 to 50 percent, but reduced both warhead weight (to 250kg) and accuracy (due to the increased range and a corkscrew re-entry trajectory). Because of shoddy manufacturing, the modified missile also had a tendency to break up during its terminal phase.[90] The corkscrewing, disintegrating missile made it in effect a maneuvering re-entry vehicle with decoys, a much more difficult target to intercept than the designed Scud warhead.[91] The prewar intelligence estimated that the Iraqis had 28 fixed and 36 mobile launchers, although Israeli intelligence put the latter figure at 50.[92]



Remains of a Scud credited destroyed by a Patriot missile during the Gulf War. Most Scuds caused little damage ...Credit: Air Defense Journal

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[88] Michael Hockett, "Air Interdiction of Scud Missiles: A Need for Alarm," Air War College, Apr 1995, 22 AUL MU43117 H6851a; Lewis, "Casualties," n2,4.

[89] James Coyne, *Airpower in the Gulf* (Arlington, VA: Aerospace Education Foundation, 1992), 12; GWAPS, vol.2, *Operations*, 211; Richard Hallion, *Storm Over Iraq: Air Power and the Gulf War* (Washington: Smithsonian, 1992), 177; Lenhart and Masse, "Persian Gulf War"; R.A. Mason, "The Air War in the Gulf," *Survival* (May/Jun 1991), 216; Stewart Powell, "Scud War, Round Two," *Air Force Magazine* (Apr 1992), 50; Stewart Powell, "Scud War, Round Three, " *Air Force Magazine* (Oct 1992), 34; Bob Woodward, *The Commanders* (NY: Simon and Schuster, 1991), 285.

[90] Rick Atkinson, *Crusade: The Untold Story of the Persian Gulf War* (NY: Houghton Mifflin,1993), 79; Friedman, *Desert Victory*, 340; McMahon, *Pursuit of the Shield*, 298; David Snodgrass, "Attacking the Theater Mobile Ballistic Missile Threat," School of Advanced Airpower Studies, n.d., 89 AUL MU43998-1 S673a. The secondary sources are in fair agreement as to the range of 375 to 400 miles, but give warhead weights that vary between 350 and 1,100 pounds. Roy Braybrook, *Air Power: The Coalition and Iraqi Air Forces* (London: Osprey, 1991), 9; Coyne, *Airpower in the Gulf*, 55; Lenhart and Masse, "Persian Gulf War," 1-2; Mason, "Air Power in the Gulf," 216.

[91] Friedman, *Desert Victory*, 340.

[92] Gulf War Air Power Survey, vol.1, *Planning* (Washington: GPO, 1993), 211; GWAPS, vol.2, *Operations*, 336; Gulf War Air Power Survey, vol.2, *Effects and Effectiveness* (Washington: GPO, 1993), 336; Michael Gordon and Bernard Trainor, *The General's War* (Boston: Little, Brown, 1995), 230; Martin Navias, *Saddam's Scud War and Ballistic Missile Proliferation* (London: Brassey's, 1991), 32; Powell, "Scud War Round Three," 34. According to one source, intelligence eventually came up with a figure of 225 launchers. Hallion, *Storm Over Iraq*, 179.

The Iraqis began their Scud assault the first night of the war, firing two missiles that landed in the sea off of Israel. In all, the Iraqis launched about 88 Scuds, slightly more at Saudi Arabia than against Israel.[93] Prior to the war there were fears that there might be fatalities as high as ten per Scud fired, an estimate in line with the five killed by each V-2 during World War II. However, this did not take into account the impact of chemical warheads, which would have inflicted greater casualties than conventional munitions.[94] Despite considerable Coalition and Israeli concerns, the Iraqis did not employ chemical warheads.

Casualties were far lower than estimated. The Israelis suffered only two direct deaths from the Scuds, and another eleven indirectly, four from heart attacks and seven suffocating in their gas masks.[95] In addition, probably 12 Saudis were killed and 121 wounded.[96] There were also American casualties. On 26 February a Scud hit a Dhahran warehouse being used as a billet by about 127 American troops, killing 28 and wounding 97 others. This one Scud accounted for 21 percent of the US personnel killed during the war, and 40 percent of the wounded.[97] A number of factors explain this incident. Apparently one Patriot battery was shut down for maintenance and another had cumulative computer timing problems. Another factor was just plain bad luck. The Scud warhead not only hit the warehouse, but unlike so many others, it remained intact, and detonated.[98] Conversely, one Scud impacted in Al Jubail Harbor about 130 yards from the USS *Tarawa* and seven other ships moored next to a pier that was heavily laden with 5,000 tons of artillery ammunition. The missile's warhead did not explode. These are the fortunes of war. Thus, the overall death rate was less than one killed per missile fired.[99]



However, on 25 February 1991 a Scud destroyed a warehouse in which Americans were billeted, killing 28, the largest number of US troops to die in one place during the Gulf War. Credit: DVIC

The Scuds lacked numbers, warhead size, and accuracy to be militarily significant. But General Norman Schwarzkopf's continued restatement of these facts not only missed the point, it was politically

[93] Coyne, *Airpower in the Gulf*, 55,122; Hallion, *Storm Over Iraq*, 186.
[94] Hallion, *Storm Over Iraq*, 186; Lewis, "Casualties," 5; Atkinson, *Crusade*, 90.
[95] Gulf War Air Power Survey, vol.4, *Weapons, Tactics, and Training* (Washington: GPO, 1993), 332.
[96] Hallion, *Storm Over Iraq*, 185-86; GWAPS, vol.4, *Weapons, Tactics, and Training*, 332.
[97] Atkinson, *Crusade*, 418,420; Gulf War Air Power Survey, vol.5, *Statistical Compendium* (Washington: GPO, 1993), 657-58; Hallion, *Storm Over Iraq*, 185.
[98] Atkinson, *Crusade*, 416-17,419; Hallion, *Storm Over Iraq*, 185; Hockett, "Air Interdiction of Scud," 40; McMahon, *Pursuit of the Shield*, 299-300.
[99] GWAPS, vol.2, *Operations*, 191; Gordon and Trainor, *General's War*, 239; Edward Marolda and Robert Schneller, *Shield and Sword: The United States Navy and the Persian Gulf War* (Washington: The Naval Historical Center, 1998), 197.

dangerous. The general's words indicated to the Israelis a lack of America's concern, and encouraged Israeli counteraction. Scuds had a great psychological and political impact, especially as they were coupled with the threat of poison gas. The Israelis were not about to stand by as Iraqi missiles showered their cities with death and destruction. If they intervened, however, the carefully constructed Coalition could quickly unravel, which, of course, was what the Iraqis intended.[100] In sharp contrast to the field commander, the top American leadership, specifically Secretary of Defense Richard Cheney and Joint Chiefs of Staff (JCS) Chairman, General Colin Powell, saw keeping Israel out of the war as the number one priority and the Scuds as the number one problem.[101]

Although the Israelis rejected American aid before the shooting started, the first Scud impact changed everything. The Israelis quickly requested both American Patriot missile assistance and Identification Friend or Foe (IFF) codes to allow their aircraft to strike Iraqi targets without tangling with Coalition aircraft. The US quickly agreed to the first, but refused the second. However, the decision makers realized that the Scud menace had to be contained to keep the Israelis out of the conflict.[102] One important element in this effort was the Army's Patriot surface-to-air missile (SAM).

The Patriot system had an extended gestation period. The Army had been concerned about defense against tactical ballistic missiles since the V-2s combat use in World War II. The ground service conducted numerous feasibility studies such as PLATO and then in the late 1950s FABMDS, Field Army Ballistic Missile Defense System. The latter yielded an Army requirement but this was rejected in November 1961 by Harold Brown, Director of Defense Research and Engineering. Following Brown's direction, the next year the Army modified the program and renamed it AADS-70s (Army Air Defense System for the 1970s). This was to focus on developing the concept and identifying the critical technologies. The two specific areas of concern were the system's phased array radar and the missile's seeker.[103] In August 1965 the Department of Defense (DoD) established a project office at the Redstone Arsenal for the system that was renamed SAM-D (surface-to-air missile development). It was to be a mobile system that included anti-missile capability that would replace both the Army's HAWK and NIKE HERCULES missiles. But the missile was designed as a point defense weapon (meaning it had limited range) against relatively lower flying and lower-speed aircraft rather than higher and faster ballistic missiles.

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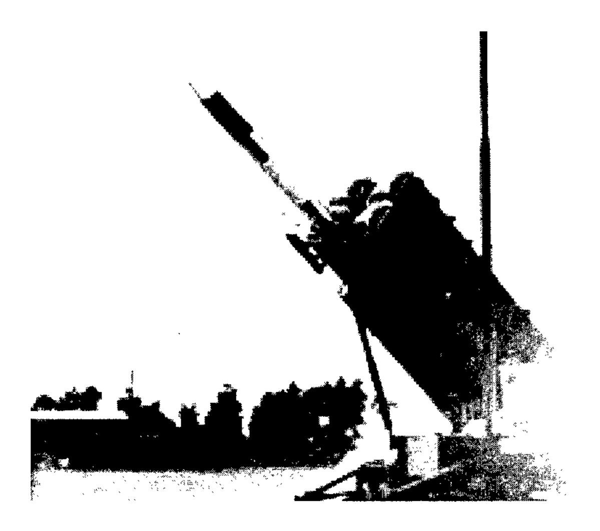
[100] There certainly was reluctance on the part of many of the Arab countries to do battle with the Iraqis. They would much rather have fought Israel. Reportedly Egyptian and Syrian soldiers cheered when they learned that Iraq had launched Scuds against Israel. GWAPS, vol.4, *Weapons, Tactics, and Training*, 35; Gordon and Trainor, *General's War*, 235.

[101] Gordon and Trainor, *General's War*, 234; Snodgrass, "Attacking TMBM Threat," 3.

[102] Gordon and Trainor, *General's War*, 231; Hallion, *Storm Over Iraq*, 180; Robert Scales, *Certain Victory* (Washington: Brassey's, 1994), 183. The Israelis may have refused the Patriot offer because of the cost, national pride, or because it competed with their own Arrow Ballistic Missile interceptor. In September they accepted a free American offer for two Patriot missile batteries, but insisted on Israeli crews. The Scuds hit before these crews completed their training, as abbreviated as it was, prompting Israeli acceptance of both American missiles and crews. McMahon, *Pursuit of the Shield*, 301-02.

[103] Donald Baucom, "Providing High Technology Systems for the Modern Battlefield: The Case of Patriot's Anti-Tactical Ballistic Missile Capability," *Air Power History* (spg 1992), 4; William Gregory, "How Patriot Survived Its Project Managers," *Interavia Space Review* (Mar 1991), 65.

In May 1967 DoD granted Raytheon the full missile development contract. In 1973 however, the new Secretary of Defense James Schlesinger wanted to cancel the project. But the deputy project manager, Charles Cockrell (1965-80) and Assistant Secretary of the Army for Research and Development, Norman Augustine, successfully argued that the project was worth saving. Schlesinger ordered changes and tests. The Army responded, simplifying the technology and cutting costs. One change mounted the missiles on a flat bed trailer. More to the point, in 1974 DoD dropped the BMD requirement in order to save money. Now SAM-D was strictly a mobile SAM to counter aircraft. The Army took a number of other cost cutting measures that trimmed the missile's capabilities, especially after the planned production buy dropped from 154 fire units to 108. In May 1976 the program was renamed Patriot (phased-array tracking to intercept of target), a rather strained acronym, but some say intended to please influential Speaker of the House of Representative Tip O'Neil of Massachusetts, while others believed that no program named Patriot would be cancelled in the nation's bicentennial year.[104]



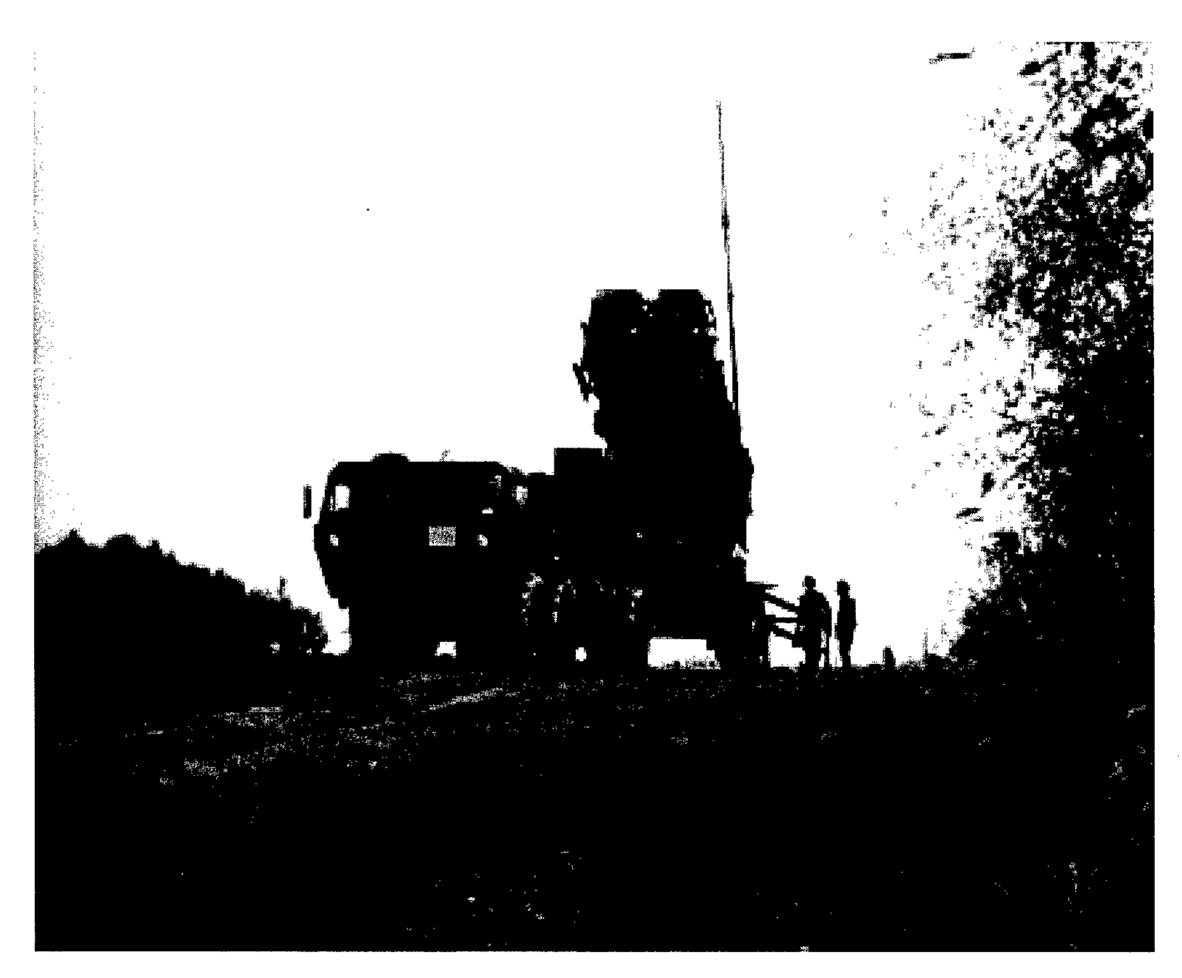
Patriot launch. The first ground based ballistic missile to see combat action, the Patriot's record in the Gulf War became the center of a highly charged argument. Credit: US Army Aviation and Missile Command

The missile first flew in February 1970. Two features distinguished it. First, it carried a conventional warhead that made its task of intercepting missiles much more difficult. This led to a new guidance system approach, called track-via-missile (TVM). A single ground based phased array radar guided the interceptor missile toward the incoming missile. As the two missiles approached one another, the interceptor's seeker attempted to detect radar energy emanated by the ground radar that had bounced off the

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[104] Richard Barbera, "The Patriot Missile System: A Review and Analysis of Its Acquisition Process," Naval Postgraduate School, Mar 1994, 9 AUL MU42525 B229p; Baucom, "Providing High Technology," 4-6,8; Tony Cullen and Christopher Foss, eds., *Jane's Battlefield Air Defence 1988-89, 9th Edition* (Coulsdon, Surrey, UK: Jane's, 1988), 206; Gregory, "How Patriot Survived," 66; Steven Hildreth and Paul Zinsmeistser, "The Patriot Air Defense System and the Search for an Antitactical Ballistic Missile Defense," Congressional Research Service, Jun 1991, 9 AUL MU42953 #91-456f.

incoming missile. This information was relayed to the ground computer to guide the interceptor toward interception. In theory this system is more accurate than others and more difficult to jam. TVM was so critical to the Patriot that in February 1974 DoD stopped the project for two years until the concept was successfully demonstrated.[105]



PAC-2 on the move. One of the advantages of the Patriot is its mobility, both strategic (it can be airlifted) and tactical. Credit: BMDO

The Patriot development was a long involved process. By October 1978 it had flown 33 flight tests and did well, as the Army scored 27 successes, 2 partial successes, 1 failure, and 3 no test. In 1979 Patriot intercepted a NIKE HERCULES. The next year the Army decided to enhance the Patriot so that it could handle a Soviet ballistic missile threat. These modifications became known as PAC (Patriot ATM Capability). The first (PAC-1) was only a minor change to the system's software and was completed by December 1988. PAC-2, the second upgrade, was somewhat more involved. It included

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[105] Barbera, "Patriot Missile System," 11,48; Baucom, "Providing High Technology," 7; Cullen and Foss, *Jane's Battlefield Air Defence 1988-89*, 206; Theodore Postal, "Lessons of the Gulf War Experience with Patriot," *International Security* (wi 1991/92), 129-33; Frank Schubert and Theresa Kraus, *The Whirlwind War: The United States Army in Operations Desert Shield and Desert Storm* (Washington: Center of Military History, 1995), 241.

changes in the software, a better warhead, a different fuze, and improved radar that gave it some capability against ballistic missiles.[106]

The Patriot was doing well. DoD granted full production authority in April 1982. In 63 flight tests in April through June 1982 the missile scored 52 successes. Therefore the Army scheduled first production deliveries for June 1982 and IOC for June 1983.[107]

Then Patriot ran into serious problems that came to light during operational testing in May and June 1983. The problem of reliability and maintainability centered on the radar, quality control issues that included faulty connections, power generators, and cables. (The contractor blamed inadequately trained troops.) Again Patriot was threatened with cancellation. Raytheon recovered from this crisis and exceeded expectations in the retest. Patriot went on to score 17 hits on 17 tests between 1986 and January 1991. Most impressive was what the Patriot promised against ballistic missiles. In September 1986 Patriot intercepted a Lance ballistic missile, and then in November 1987 intercepted another Patriot acting as a surrogate for an incoming ballistic missile.[108]

The 2,200-pound missile (at launch) carries a 200-pound conventional warhead up to almost 79,000 feet and out to a distance of 37nm. The Patriot's ground electronics system can simultaneously track up to 50 targets and handle 5 engagements at the same time. It is able to defend an area 20km forward of its position and 5km to both right and left. (The defended area is referred to as its "footprint.") Four missiles are mounted on a trailer that is pulled by a tractor or a truck. The Army planned to buy 122 fire units with a total of 7,063 missiles by March 1986.[109]

The Army's Patriot surface-to-air missile formed the last line of active defense against the Scuds. The US was able to airlift 32 Patriot missiles to Israel within 17 hours and get them operational within three days. Patriot deployment to the Gulf eventually consisted of seven batteries to Israel, 21 to Saudi Arabia, and four to Turkey.[110]

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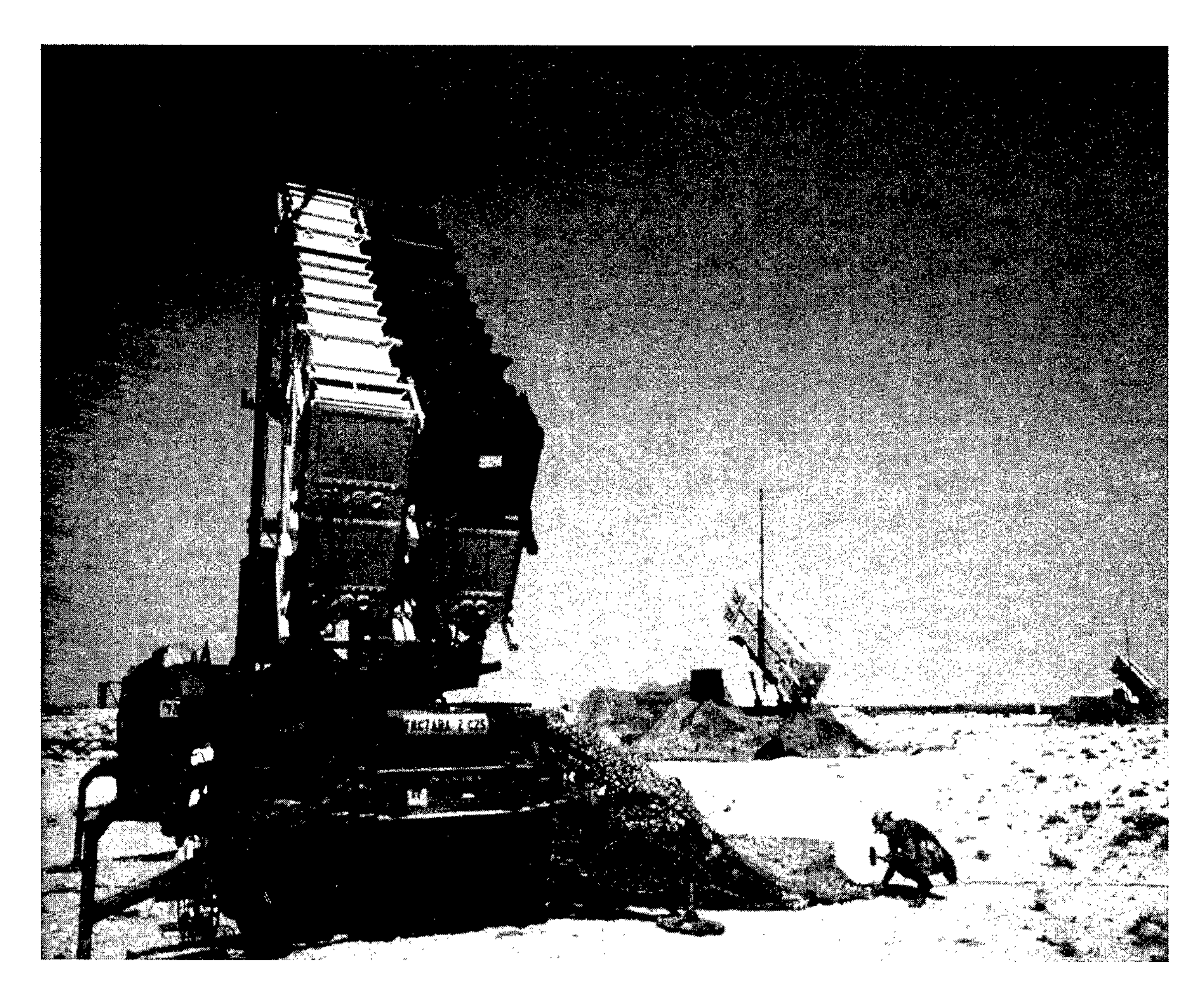
[106] Barbera, "Patriot Missile System," 13-14,23-24; Baucom, "Providing High Technology, " 7,9.

[107] Barbera, "Patriot Missile System," 13-16.

[108] Barberta, "Patriot Missile System," 17; Baucom, "Providing High Technology," 9; Cullen and Foss, *Jane's Battlefield Air Defence 1988-89,* 206; Hans Fenstermacher, "The Patriot Crisis," Kennedy School of Government Case Program, 1990, 3,5,7-9,13; Gregory, "How Patriot Survived," 67; Hildreth and Zinsmeistser, "Patriot Air Defense System," 11.

[109] Jorg Bahneman and Thomas Enders, "Reconsidering Ballistic Missile Defence," *Military Technology* (4/91), 50; Barbera, "Patriot Missile System," 22,37,65; Cullen and Foss, *Jane's Battlefield Air Defence 1988-89,* 209; Schubert and Kraus, *Whirlwind War*, 264.

[110] GWAPS, vol.2, *Effects and Effectiveness*, 118; Hallion, *Storm Over Iraq*, 180; Snodgrass, "Attacking TMBM Threat," 87.



Patriot deployed during the Gulf War. The US deployed considerable numbers of Patriots to defend friendly forces and civilians in both Israel and Saudi Arabia. Credit: DVIC

Crucial to the active BMD was early warning provided by strategic satellites. Although American Defense Support Program (DSP) satellites were designed to give warning of ICBM launches, they demonstrated the ability to track the lower flying, cooler, short range, tactical ballistic missiles, as demonstrated against hundreds of tactical ballistic missiles during their tests and in two Mid-Eastern wars.[111] Before the shooting started in the Gulf War, two young captains at Strategic Air Command (SAC), John Rittinghouse and J.D. Broyles, worked out a system that coordinated information from the satellites, routed it through three widely located headquarters (SAC, Space Command, and Central Command), and passed it along to the user in the field. While the satellite did not precisely indicate either the location of launch or anticipated point of impact, it did give general information. The bottleneck was the communications, nevertheless, the jury-rigged system gave a few minutes' warning to both the defending Patriot crews and people in the target area. During the war, the satellites detected all 88 launches.[112]

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[111] Donald Kutyna, "Space Systems in the Gulf War," draft, 138.

[112] Gulf War Air Power Survey, *Command and Control* (Washington: GPO,1993), 248-50; GWPS, *Weapons, Tactics, and Training*, 280-81. This warning was a factor in the relatively low casualty rate. During World II one reason why the V-2 ballistic missile was so much more deadly (5 killed per missile)

One of the main controversies of the war centered on the effectiveness of the Patriot against the Scud, or more precisely, how many Patriots hit Scuds. Of the 88 Scuds launched, 53 flew within the area of Patriot coverage. The defenders engaged most of these, 46 to 52 according to secondary accounts, with 158 Patriot missiles.[113] Schwarzkopf initially claimed 100 percent Patriot success. After the war the manufacturer boasted of 89 percent success over Saudi Arabia and 44 percent over Israel, then in December 1991 the Army asserted 80 percent and 50 percent success, repectively. The next April the official success claims were further reduced to 70 and 40 percent in the two areas.[114]

Outside experts criticized these claims of success. This dispute degenerated into an ugly war of words waged in the press, halls of congress, and the pages of academic journals. Congressional researchers noted that the Army had little evidence on which to base its claims. The General Accounting Office stated that while the Army was highly confident that 25 percent of the engagements resulted in kills of the Scud warhead, it only had the strongest supporting evidence in one-third of these cases. "Contrary to most media reports," an August 1999 article in the prestigious journal *Scientific American* stated that Patriot "failed in most or all 44 of its attempts to destroy Iraqi Scud missiles...."[115] One of Patriot's most visible critics, Theodore Postal of MIT, wrote that his studies "indicate[d] that Patriot was a near total failure in terms of its ability to destroy, damage, or divert Scud warheads that were engaged in *both* Saudi Arabia and Israel."[116] Postal went on to state that there was only one clear example of a hit, but that it was uncertain whether this impacted on a Scud warhead or fuel tank. He approvingly quoted Yitzhak Rubin: "The biggest disappointment of the war is reserved for the Patriot. It was excellent public relations, but its intercept rate was rather poor...."[117]

Postal claimed that not only was the Patriot unsuccessful in neutering the Scud, it caused damage. The defenders fired three Patriots at each of the incoming Scuds, and

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than the V-1 flying bomb (more than 0.6 kills per missile) was that the former gave no warning as it arrived at supersonic speeds, while the latter flew at subsonic speeds with a very distinctive sound that stopped prior to its last plunge. Hallion, *Storm Over Iraq*, 186; Kenneth Werrell, *The Evolution of the Cruise Missile* (Maxwell AFB, AL: Air University, 1985), 60-61. For slightly different figures, but the same conclusion, see Lewis, "Casualties," 4-5. The satellites were not infallible, for example on one occasion they mistook a B-52 strike for a Scud launch. Tom Clancy with Chuck Horner, *Every Man a Tiger* (NY: Putnam, 1999), 385,464; Gary Waters, *Gulf Lesson One-The Value of Air Power: Doctrinal Lessons for Australia* (Canberra: Air Power Studies Centre, 1992), 217.

[113] Coyne, *Airpower in the Gulf*, 122; Hallion, *Storm Over Iraq*, 185; Powell, "Scud War, Round Three," 35; Snodgrass, "Attacking TMBM Threat," 90. Two of the 88 Scuds did not reach the target area. GWAPS, vol.4, *Weapons, Tactics, and Training*, n280.

[114] GWAPS, vol.2, *Effects and Effectiveness*, n118; Snodgrass, "Attacking TMBM Threat," 88-89.

[115] George Lewis, Theodore Postol, and John Pike, "Why National Missile Defense Won't Work," *Scientific American* (Aug 1999).

[116] Ted Postal, letter to the editor, *International Security* (sum 1992), 226; General Accounting Office, *Operation Desert Storm: Data Does Not Exist to Conclusively Say How Well Patriot Performed*, Sep 1992, 3-4; Steven Hildreth, "Evaluation of U.S. Army Assessment of Patriot Antitactical Missile Effectiveness in the War Against Iraq, " Congressional Research Service, Apr 1992, 7,16.

[117] Postal letter, 235n26,237-39.

each interceptor missile weighed more than did the Scud's warhead. Thus some critics asserted that the Patriots may have caused more ground damage than did the Scuds.[118]

This misses the main point: regardless of the exact interception figures, Patriots proved very effective. Just as the Scuds were primarily a psychological weapon, so too were the Patriots. They provided great theater, with live videos of fiery launches, smoke trails, and aerial fireworks made more vivid with a dark, night background that had a positive impact on civilians and decision makers in the US, Saudi Arabia, and Israel. (There is no indication that any Iraqis saw this very visible performance, and if so, what impact it had on them.) The situation was manageable for the defenders as long as the Scud attacks were limited in number, inaccurate, and killed few people. Missile warning protected civilians from death and injury, while active missile defenses bolstered morale. The Patriots were an important factor in keeping Israel out of the war.

Another factor in deterring Israel's intervention was the intense direct offensive campaign waged against the Scuds. Initially the airmen were confident that they could handle the Iraqi missiles. In December 1990 the Coalition air commander, General Charles Horner, stated that air power would preclude an Iraqi missile attack. The airmen maintained this view even after exercises in late 1990 against actual Scud launchers yielded disappointing results. Nevertheless, they believed that the Scuds could be neutralized by destroying the Scud's fixed launch sites, the engine manufacturing facilities, and fuel production plants.[119] The military was confident that planned attacks and overwhelming air power would destroy the Scuds or intimidate the Iraqis. The airmen badly underestimated the problem. Despite launching almost 2,500 scout and 1,500 strike sorties (3.5 percent of the Coalition total scheduled) against the Scuds, of which about half delivered ordnance, the attacks continued. This was about three times the effort the planners had anticipated. The level of frustration is evident in a plan that General Horner suggested late in January that would employ almost the entire Coalition air armada in a three-day campaign to attack most structures in western Iraq, as well as mine all of the roads. Schwarzkopf would not approve the scheme because it would divert the air forces for three days, and yet not guarantee success. Overall, the airmen claimed about 80 mobile launchers destroyed.[120]

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[118] Theodore Postal, "Lessons of the Gulf War Experience with Patriot," *International Security* (wi 1991/92), 146; Theodore Postal, "Lessons for SDI from the Gulf War PATRIOT Experience: A Technical Perspective," Testimony before the House Armed Services Committee, 16 Apr 1991, 4 AUL 358.174 P858p. For a defense of the Patriot see Robert Stein, "Patriot ATBM Experience in the Gulf War," *International Security* (sum 1992), 199-225. The participants in this fight had a specific agenda and were contesting the facts and impact of the Patriot's Gulf War performance on SDI and National Ballistic Missile Defense. For a more balanced view see Alexander Simon, "The Patriot Missile: Performance in the Gulf War Reviewed," Jul 1996 internet www.cdi.org/issues/bmd/Patriot.html.

[119] Scud fuel was unstable with a storage life of only four to six weeks. Clancy, *Every Man a Tiger*, 379.

[120] Atkinson, *Crusade*, 147-48,175; Clancy, *Every Man a Tiger*, 321,379; GWAPS, vol.2, *Operations*, 182; GWAPS, vol.2, *Effects and Effectiveness*, 330,335; GWAPS, vol.5, *Statistical Compendium*, 418; Gordon and Trainor, *General's War*, 237-38; Thomas Keaney and Eliot Cohen, *Revolution in Warfare?* (Annapolis: Naval Institute, 1995), 73,n73; Mason, "Air War in the Gulf," 217; Snodgrass, "Attacking TMBM Threat," 3.

The Army joined the Air Force in the anti-Scud campaign. American surface-to-surface rockets ATACMS (Army Tactical Missile System) and American and British special forces were also involved in the anti-Scud campaign. The elite troops scouted the likely launch sites, observed, reported, and attacked Scud targets, both by direct attack and by calling in Coalition aircraft. According to secondary sources they claimed between 10 and 20 Scud launchers destroyed.[121] But to be clear, despite this massive Coalition air and ground effort, there is no confirmation of the destruction of a single mobile Scud launcher.[122]

One of the principal reasons for this lack of Coalition success was that, in sharp contrast to their other operations, the Iraqi performance with Scuds proved competent, clever, and innovative. They made good use of high-fidelity East German decoys, which reportedly could not be distinguished from the real item at distances greater than 25 yards. The Iraqis also used their own decoys and radar reflectors to spoof Coalition reconnaissance and attack. As a consequence the airmen destroyed numerous oil transporters they believed to be TELs. The airmen also were surprised and outmaneuvered when the Iraqis did not follow the Soviet pattern of operations. For example, the Iraqis made little use of radios that Coalition electronic reconnaissance aircraft could detect, track, and target, but instead relied on land lines, couriers, and prior orders. The Scud crews became very proficient at "shoot and scoot" tactics. They greatly reduced the time it took to set up and launch a missile from the expected 30 minutes to between 6 and 10 minutes, and the time to depart that location from 30 minutes to between 5 and 6 minutes. This reduced missile accuracy, but was of little import as Scuds already were inaccurate, and in fact were being used as a terror weapon requiring little accuracy. Even when the airmen directly observed Scud launches, they were unable to do much. In the 42 cases in which the aircrews spotted Scud launches, the airmen were only able to attack eight times. A further complication was that 80 percent of the Scud launches were at night. When stationary, the mobile launchers were hidden in town and cities, culverts, agricultural areas, underpasses, and shelters. After the war United Nations inspection teams found 62 missiles and 10 TELs. The Iraqis may have hidden more Scuds and TELs.[123]

In short, the Scuds were the greatest difficulty encountered by US forces in the Gulf War. For unlike the great success in the rest of the war, the Scuds remained a problem to the very end. Although not a military threat and inflicting few casualties, they certainly presented a valid threat to the Coalition's unity. The Scud campaign diverted

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[121] Like many other Army officers, Schwarzkopf did not favor Special Forces. Atkinson, *Crusade*, 177-81; GWAPS, vol.2, *Effects and Effectiveness*, 331; Gordon and Trainor, *General's War*, 241,245-46; Hallion, *Storm Over Iraq*, 181; Keaney and Cohen, *Revolution in Warfare*, 73; Scales, *Certain Victory*, 186.

[122] GWAPS, vol.2, *Effects and Effectiveness*, 330.

[123] Atkinson, *Crusade*, 240; Richard Davis, "Strategic Bombardment in the Gulf War," 598 in R. Cargill Hall, ed., *Case Studies in Strategic Bombardment* (Washington: Air Force History and Museums Program, 1998); GWAPS, vol.2, *Operations*, 181; GWAPS, vol.4, *Weapons, Tactics, and Training*, 280; Hockett, "Air Interdiction of Scud," 31; Keaney and Cohen, *Revolution in Warfare?*, 75,108; Snodgrass, "Attacking TMBM Threat," 5,8; James Winnefeld, Preston Niblack, and Dana Johnson, *League of Airmen* (Santa Monica, CA: RAND, 1994), 132; Centre for Defence and International Security Studies, "The Great Scud Hunt: An Assessment," 1 www.cdiss.org/scudnt6.htm.

considerable resources. However questionable BMD was in fact, it appeared successful to the press and public, and this political and psychological impression was most important. The airmen's failure stemmed from a number of factors, the most significant of which was that mobile launchers are difficult to detect, track, target, and destroy when operated by a competent foe.[124] Some authors point to faulty intelligence, an exaggerated faith in air power, and a skepticism about special forces.[125]

While the airmen did not perform as they would have liked against the Scuds, apparently they did enough to help keep the Israelis out of the war. The airmen also can take some credit for reducing the Iraqi launch rates below those seen in the Iran-Iraq War, especially since the Iraqis had more missiles in 1991. The postwar Air Force study of the conflict credits the air campaign with reducing the Iraqi launches by half. Suppressing the launch rate meant the Iraqis could not fire in salvos that had the potential to swamp the Patriots.[126] And compared to the German's World War II V-2 campaign, the Scuds proved much less deadly, in part due to Coalition defensive efforts. In brief, the Iraqis beat the Coalition in this area as high technology could not find the dated tactical ballistic missiles, so they could be destroyed. This was the greatest lapse; the one clear, but fortunately, not a significant failure of the air campaign. But we should not make too much of this, for in balance it was only a minor counterpoint. Had the war not been so overwhelmingly successful in all its other military aspects, for example had there been substantial casualties or stouter Iraqi resistance, the Scud story would loom much less large and probably deserve only a brief footnote, at best.

The Patriot-Scud duel had implications well beyond the Persian Gulf and the conflict there. The Iraqi Scud indicated the threat that the US and its friends face. The war showed how this crude weapon could create great political problems and force a significant diversion of military resources. Especially grave were the implications of ballistic missiles armed with nuclear, biological, or chemical warheads. The apparent success of the Patriot against the Scud gave impetus to BMD programs.

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[124] Winnefeld, Niblack, and Johnson, *League of Airmen*, 132,134.

[125] Gordon and Trainor, *General's War*, 228; Operations Desert Shield/Desert Storm [briefing] 70 HRA K178.82-1087.

[126] GWAPS, vol.4, *Weapons, Tactics, and Training*, 292-93; Gordon and Trainor, *General's War*, 240. The Scud problem could have been much worse. If the missile had been more modern, it could have been maneuvering and more accurate. It also could have been used in greater numbers, armed with chemical warheads, or with a more dependable warhead. (Of 39 warhead that impacted in Israel, only a third detonated. Lewis, "Casualties," 1.)

Ballistic Missile Defense in the 1990s

Iraqi employment of Scud ballistic missiles in the Gulf War brought the problem of ballistic missile attack to the uppermost attention of decision makers, press, and public. Iraqi Scud use highlighted the threat while the seemingly effective Coalition use of Patriot missiles promised a solution. Meanwhile the circumstances surrounding the entire ballistic missile defense debate shifted in two important ways: the technology improved and the threat changed. At the same time ballistic missile defense (BMD) was more clearly seen to consist of two different parts: National Missile Defense (strategic defense of the homeland, NMD) and Theater Missile Defense (tactical, TMD).

The breakup of the Soviet Union (officially in 1991) marked the end of the Cold War and dramatically rearranged both the balance of strategic power and the nature of the threat. On the positive side, the lessening of tensions between the former Soviet Union and the United States greatly reduced the possibilities of an all-out nuclear exchange between the two countries. The fragmentation of the Soviet Union, however, presented new challenges. The vast numbers of Soviet strategic missiles now came under the control of numerous new states. The former Soviet Union, although losing territory, power, and missiles, still possessed a formidable arsenal. There were fears for the security of these nuclear weapons, as underscored by the abortive coup against Premier Mikhail Gorbachev in August 1991. Now the threat from the former Cold War adversary seemed to be less that of a massive, planned strike, and more that of an accidental or unauthorized launch (action by a rogue commander or perhaps a rebel group).

The second new problem was that of proliferation of weapons of mass destruction (nuclear, biological, and chemical, NBC) and of ballistic missiles. If some could accept such weapons in the hands of such "responsible states" as Britain, France, and Israel, or ignore or tolerate them in India and Pakistan, the same was not the case with "terrorist sponsoring states" such as Iran, Iraq, Libya, North Korea, and Syria. This was more than just a western perception, as a congressional delegation that visited Russia in 1991 found concern there about third world ballistic missiles and less rigidity on the ABM Treaty.[127]

In recognition of these changes, the US changed the focus of the ballistic missile defense (BMD)[128] program. In his 1991 State of the Union address, President George Bush announced that the American BMD would be redirected from defending against a massive Soviet ballistic missile (Intercontinental Ballistic Missile, ICBM and Submarine Launched Ballistic Missile, SLBM) strike to defeating a more limited missile attack of up

[127] David Dennon, *Ballistic Missile Defense in the Post-Cold War Era* (Boulder, CO: Westview, 1995), 11.

[128] Whereas I have used the term antiballistic missile (ABM) to denote defense of the homeland against intercontinental ballistic missiles (ICBM) in the period up into the 1970s, after that time I have used the more general term, ballistic missile defense (BMD) to indicate both homeland defense, more specifically referred to as national missile defense (NMD) and theater missile defense (TMD).

to 200 warheads. This was summed up in the system's new name, Global Protection Against Limited Strikes (GPALS). It would redirect the Strategic Defense Initiative (SDI) into a three fold program consisting of theater defenses for Allies and forward deployed US troops, defense of stateside Americans, and a space-based system to fend off an attack anywhere in the world.[129]

Another consequence of the demise of the Soviet Union was that the discipline of the Cold War, that is two super powers keeping their Allies and clients under control, was no more.[130] Thus the threat expanded with the proliferation of both missile technology and NBC weapons to a host of countries considered less stable, conservative, and predictable than the Soviet Union was during the Cold War. The question was whether deterrence, the cornerstone of the Cold War system, would work in this new environment. The world community attempted to deal with the problem of proliferation with the 1987 Missile Technology Control Regime that limited the sale of ballistic missiles. The five nuclear powers and 20 states with ballistic missile capability were involved in this treaty that restricted sales of ballistic missiles with ranges over 500km and payloads of more than 500kg. In 1993 the signatories tightened the deal to lower the range of missiles covered by the treaty to 300km.[131] The results have not been reassuring.

As a result, the American focus shifted from defense against Soviet strategic missiles, NMD, to defense against tactical missiles, TMD, more likely to be acquired by smaller countries. While this shift in emphasis was not immediately seen in funding, after all action in the government project takes some time, by 1993 spending on TMD greatly exceeded that spent on NMD. The new Clinton Administration continued this trend.[132]

President William Clinton had promised a tighter Defense budget than his Republican opponent in the 1992 election campaign and did cut defense spending after taking office. This, along with the changed international situation, led to the renaming of the SDI program and its patron organization SDIO (Strategic Defense Initiative Organization) in May 1993 to Ballistic Missile Defense Organization (BMDO). More significant than this name change, the new administration conducted a study of the post-Cold War US defense requirements, a Bottom Up Review (BUR), that emerged in October 1993. It continued the trend that emphasized TMD at the expense of NMD, placing TMD first in priority. Specifically, the administration cut overall BMD funding for fiscal years 1995-99 in half and increased TMD funding for the five-year period to

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[129] Donald Baucom, *The Origins of SDI, 1944-1983* (Lawrence, KS: University Press of Kansas, 1992), 199; Ballistic Missile Defense Organization, Fact Sheet, "Ballistic Missile Defense Organization Budgetary History," 2 http://www.acq.osd.mil/bmdo/ bmdolink/htm/tmd.html; Dennon, *Ballistic Missile Defense*, 8-10; General Accounting Office, *Theater Missile Defense Program: Funding and Personnel Requirements Are Not Fully Defined*, Dec 1992, 1-2.

[130] Neither the Americans nor Soviets gave nuclear weapons to their Allies. The British, French, and Israelis developed their own small nuclear arsenals.

[131] Richard Falkenrath, "The United States and Ballistic Missile Defense after the Cold War," Center for Science and International Affairs [Harvard], Oct 1994, 5.

[132] BMD funding shifted from $1103 million on TMD in 1993 and $1886 on NMD, to $1646 million and $553 million in 1994. BMDO, "Fact Sheet, Ballistic Missile Defense Organization," 1.

$12 billion, while leaving NMD at $3 billion.[133] It established TMD with top priority based around three core programs: Patriot improvement (PAC-3); improvement of the Navy's Aegis program; and the Army's Theater High Altitude Area Defense (THAAD) program. Three other TMD systems would compete to join this select group. These competitors included the Navy upper tier system, a mobile Army system then known as Corps-SAM; and a third system to provide boost phase intercept capability. BUR assigned NMD second priority, reducing it to a focus on technical problems.[134] The overall concept was to build a multi-layered system based in space, atmosphere, and on the ground.

Congress responded to the increased interest in ballistic missile defense. The 1991 Congressional National Defense Act legislated very specific goals for both TMD and NMD. The legislators called for deployment of an advanced TMD system by the mid-1990s and for a cost-effective and operationally effective NMD system by 1996. The latter was to be compliant with the 1972 ABM Treaty.[135] The administration had few qualms over TMD, but was clearly less positive about NMD as it saw international agreement as a better solution to the missile problem than a technical solution. But Republican congressional victories in fall 1994 changed the Washington power equation. Led by the aggressive Speaker of the House of Representatives, Newt Gingrich, the Republicans put forth a bold "Contract with America" that included the commitment to pass legislation to deploy a limited NMD system. Congress persisted, and in the Missile Defense Act of 1995 pushed for a limited NMD. The legislative branch wanted to revise the ABM Treaty, but failing Russian agreement, was willing to consider withdrawing from the Treaty. It was thinking in terms of a multi-site NMD system that would include space sensors and could defend all 50 states. By this time the operational date (Initial Operational Capability, IOC) was pushed back to 2003. In January 1996 President Clinton vetoed the bill, on the grounds that it violated the existing treaty. The next month the administration countered with a program that called for a "3 plus 3" option. That is, there would be three years of development that would be treaty compliant, and then a decision made that, if positive, would permit limited deployment in another three years. Thus, the US might field NMD by the year 2002 or 2003.[136]

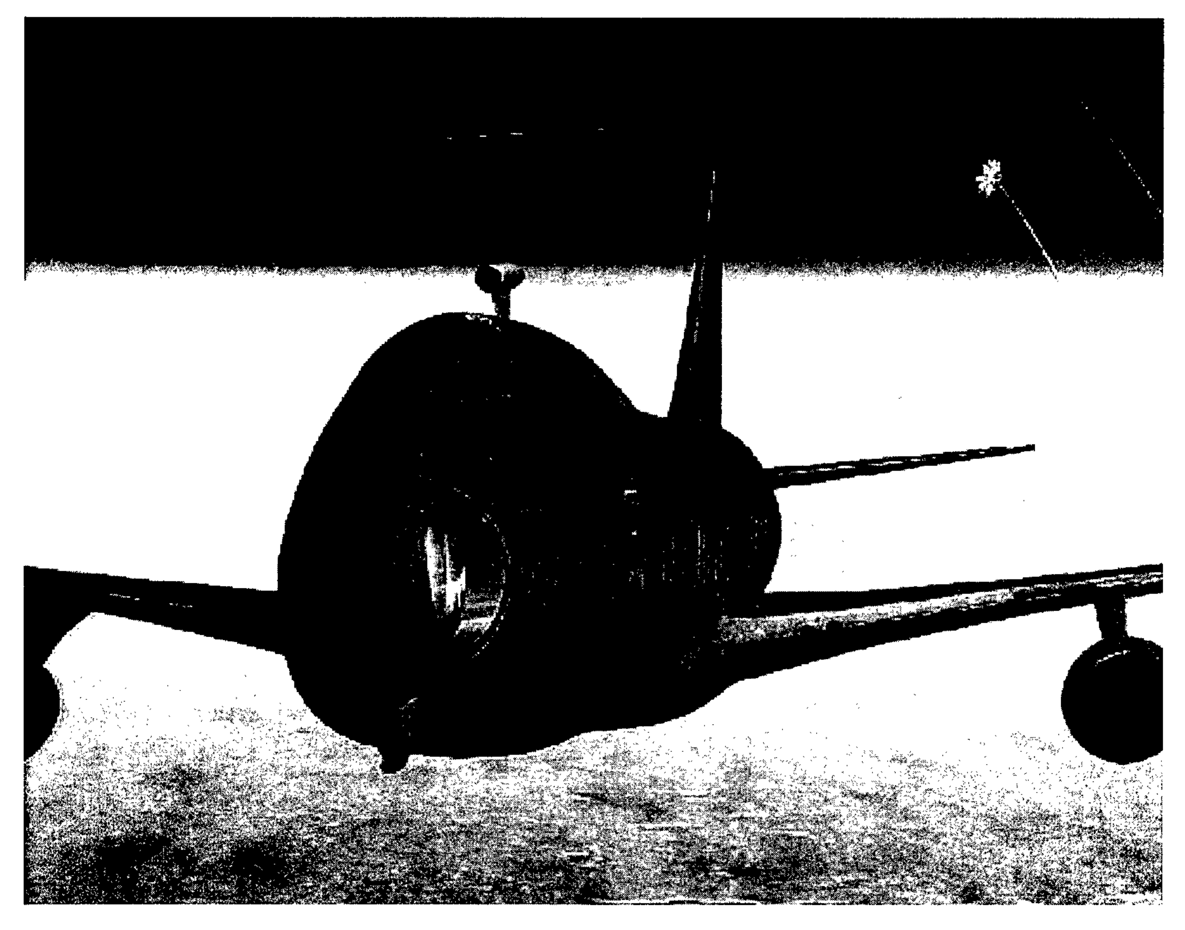
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[133] American Institute of Aeronautics and Astronautics, *Theater Missile Defense: Systems and Issues, 1994*, Jun 1994, 3,8; Dennon, *Ballistic Missile Defense*, 14,54.

[134] BMDO, "Fact Sheet, Ballistic Missile Defense Organization," 2.

[135] James Walker, Frances Martin, and Sharon Watkins, *Strategic Defense: Four Decades of Progress* (n.p.: Historical Office US Army Space and Strategic Defense Command, 1995), 107.

[136] BMDO, Fact Sheet, "History of Ballistic Missile Defense," 3; Federation of Atomic Scientists, "National Missile Defense," 8; David Grogan, "Power Play: Theater Ballistic Missile Defense, National Ballistic Missile Defense and the ABM Treaty," Masters of Laws thesis, George Washington University Law School, May 1998, 57-64.



Airborne Laser. A fleet of seven ABLs is scheduled to enter service before the end of the decade. Credit: Airman's Magazine

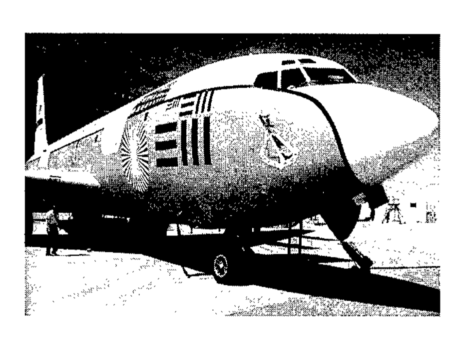
Laser Weapons

Perhaps it is appropriate to begin with the most exotic, futuristic, and promising weapons, lasers. Interest in using lasers against ballistic missiles rose to public attention during the SDI phase of the ballistic missile defense debate in the 1980s. These weapons held the promise of long range, quick results (they operated at the speed of light), through destruction of enemy ballistic missiles during their boost phase over hostile territory. The US had three laser programs under development, mounted on different platforms to fulfill the role of boost phase interceptor (BPI). The most prominent is the Airborne Laser (ABL), a directed energy weapon carried by a modified 747 aircraft. The second program is a space based directed energy weapon.[137] The Air Force and Army were given joint responsibility for lasers based in space (SBL, Space Based Laser).[138]

[137] Another boost phase interceptor program is to mount a kinetic energy weapon aboard an unmanned vehicle. This is a backup for the other two BPI programs. Ballistic Missile Defense Organization, Fact Sheet, "Unmanned Aerial Vehicle Boost Phase Intercept Program," 1.

[138] Reiss, *Strategic Defense Initiative*, 87; Walker, Martin, and Watkins, *Strategic Defense*, 71.

The USAF was responsible for the development and testing of an airborne laser (ABL). The Air Force employed a modified KC-135 as an airframe in eleven years of laser experiments. During these tests that ended in 1983, the system destroyed five AIM-9 Sidewinder missiles and a BQM-34A target drone. As already noted, the Gulf War spurred interest in missile defense systems, specifically against tactical ballistic missiles. In January 1993 there was a series of airborne laser experiments (Airborne Laser Experiment, ABLEX) and high altitude balloon experiments (HABE) that collected data on an airborne version of the proposed weapon. In May 1994 the Air Force selected two teams to develop concepts for an ABL. This effort was to field a scaled demonstrator by January 1997 and demonstrate lethality by 2000.[139]



Airborne laser laboratory. The Air Force conducted considerable number of experiments to support the concept of an laser based on an airborne platform to destroy ballistic missile during the boost phase. Credit: DVIC

In November 1996 the Air Force focused the effort when it awarded a $1.1 billion contract to a team headed by Boeing (including Lockheed-Martin, and TRW) to develop and flight test the ABL. The planners envisioned mounting a laser on a modified Boeing 747 to operate above the clouds at about 40,000 feet. It also would be equipped with aerial refueling capability enabling the system to operate around the clock. The large aircraft, manned by a four-man crew, would carry the chemicals and apparatus to permit the air-to-air engagement.

To function as planned, the ABL will have to overcome a number of serious technical problems. First, the target has to be detected and tracked. Then, the laser has to sight in on its target and maintain a steady hold on its aiming point (overcome "jitter") despite turbulent atmosphere, overcome atmospheric absorption of its beam, maintain beam shape, and counteract thermal blooming.[140]The equipment has to be small and light enough to be carried in a 747 to operate above the clouds (at about 40,000 feet), as well as rugged enough to operate after flying through rough weather and surviving hard landings. In addition, it must be powerful enough to destroy the target, and capable of multiple engagements.[141] Last, but not least, it also must be able to overcome obvious

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[139] Stephen Coulombe, "The Airborne Laser: Pie in the Sky or Vision of Future Theater Missile Defense?," *Air Chronicles* (Apr 1994); Federation of Atomic Scientists, "Airborne Laser Laboratory," 1; J.W. Schomisch, *1994/95 Guide to Theater Missile Defense* (Arlington, VA: Pasha,1994), 83-84.

[140] An example of the system's complexity is the difficulty of the long range laser engagement. Atmospheric turbulence, caused by different air temperatures, both weakens and distorts the laser. The system uses adaptive optics to combat this problem, a deformable mirror, sometimes called a "rubber mirror." It compensates for this problem by using 341 actuators capable of changing the shape of the mirror at a rate of 1,000 times per second. The mirror itself is finely polished to a precision of 3,000 times thinner than a human hair. FAS, "Airborne Laser," 1.

[141] Coulombe, "Airborne Laser"; John Donnelly, "Cutting Corners, Not Pounds," *Defense Week* (5 Apr 1999), 6; William Possell, "Lasers and Missile Defense: New Concepts for Space-Based and Ground Based Laser Weapons," Occasional Paper No.5, Air War College, Jul 1998, 13; John Tirpak, "Military Lasers High and Low," *Air Force Magazine* (Sep 1999), 52.

enemy countermeasures. These include hardening, spinning, or using reflective paint on the missile. The ABL can also be overwhelmed by mass missile launches.[142]

The concept of operations is deceptively simple. Although space assets can cue the ABL, it will be capable of autonomous operations using infrared devices to spot and track the target. The ABL requires four laser shots to destroy the target. The first would enable the ABL to calculate the target's direction and speed, followed by a second that would allow the fire control system to lock on. A third laser would determine the atmospheric distortion and permit the system to adjust the laser's on-board mirrors. The fourth laser would then fire a burst from a gimbaled nose turret to destroy its target. It will hold a steady position on the target's skin for three to five seconds, heating, rupturing, and causing the fuel contained within to explode. The system has the ability to engage between 20 and 40 targets. Open sources indicate it can detect, aim, and fire within ten seconds at a range between 200 and 900 miles. While the main focus was to defend against tactical ballistic missiles, the ABL could also destroy aircraft, cruise missiles, and ground targets. [143]

The Air Force picked the chemical oxygen iodine laser (COIL) system from three potential systems that were considered. It was invented at the Air Force Weapons Laboratory in 1977 and demonstrated a year later. COIL offers the advantage of a shorter wavelength than competitor lasers, allowing smaller optics and less power loss through atmospheric absorption.[144]

The Air Force plans to buy seven airframes, with the first delivery in fiscal year 2003 and the last in 2009. The system is scheduled to achieve a limited operating capability in 2004, IOC with three aircraft in 2007, and full operating capability in 2009. The seven aircraft are intended to insure there will be five platforms deployable at any time. Secondary sources use a lifetime cost of just over $11 billion.[145]

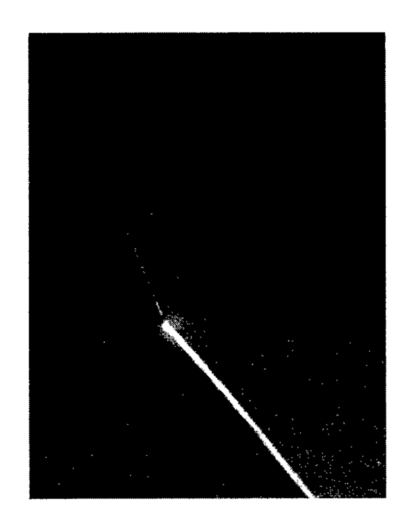
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[142] John Donnelly, "Airborne Laser Found Unlikely to Meet Range Requirements,""*Defense Week* (8 Mar 1999).

[143] ABL range is important for two reasons. First, greater range means greater coverage of potential launch sites. Second, greater range will give the ABL stand off distance against surface-to-air missiles that might defend the launch sites. Jonathan Campbell, "Airborne Laser (ABL) Input," 8 Mar 2000; USAF, "1997 United States Air Force Issues Book: Airborne Laser," 1; FAS, "Airborne Laser," 1; Federation of Atomic Scientists, "Airbone Laser Resources," 5; Mike Maharry, "Airborne Laser Steps Forward," *Tacoma News Tribune* (26 Jan 2000), D1; Tirpak, "Military Lasers High and Low," 50,52; George Tibbits, "Boeing Starts Assembly of Freighter to Carry Air Force 'Death Ray,'" *Seattle Times* (11 Aug 1999); Sue Vorenberg, "Air Force Lasers Precisely Slice Through Atmosphere," *Albuquerique Tribune* (10 Apr 2000).

[144] FAS, "Airborne Laser," 1; Possell, "Lasers and Missile Defense," 16-18.

[145] Campbell, "Airborne Laser (ABL) Input"; John Donnelly, "Pentagon Looks to Delay Airborne Laser Development," *Defense Week* (13 Dec 1999), 1; Michael Kilian, "Air Force to Test Anti-Missile Laser Airplane," *Chicago Tribune* (26 Jan 2000), 5; Tirpak, "Military Lasers High and Low," 53.



Patriot PAC-3 test February 2000. This version is more advanced than the model that was used in the Gulf War, with a number of improvements, and a different (hit-to-kill) warhead. Credit: BMDO

As the futuristic system entered the new century, it faced numerous obstacles. First of all, it had technical problems. A 1999 Congressional Research Service report indicated that the ABL had marginal power beyond 300km and might have trouble tracking missiles at ranges greater than 300km. This was short of the 200 to 900 mile range claimed for the system. The problem of generating enough power led the designer to beef up the system, adding weight that exceeded plans. The result may well be that the aircraft will be unable to cruise at the planned 40,000 feet and thus subject the lasers to increased atmospheric resistance as well as clouds at the lower altitudes. In any event, the first live intercept test is not scheduled until late 2003.[146]

The system also faces financial problems, although the Air Force considers this program second in priority only to its F-22 air dominance fighter. In early 1999 a trade periodical reported that the life cycle costs were expected to increase $.3 billion over the $11 billion estimate. More serious, in January 2000 the Pentagon proposed cuts of $.639 billion to the program over a five year period. If that "draconian cut" was made, Boeing (the lead contractor) claimed that the IOC would be delayed by seven years and life cycle costs increased by $1.2 billion.[147]

A less grand laser effort was also in the works. Since the mid-1990s the US and Israel had been developing a laser device to destroy the short-range Katyusha rockets that bombard and threaten northern Israeli border settlements. The Tactical High Energy Laser (THEL) is designed to have an initial range of four miles. It was tested against a stationary target in May 2000 and is scheduled for tests against missiles before the end of the year. If these are successful, it will permit IOC early in 2001.[148] This is an ambitious schedule, but encouraged by the Israeli pullout from southern Lebanon in May 2000 that left northern Israeli settlements more exposed to rocket attack.

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[146] Donnelly, "Airborne Laser Found Unlikely"; John Donnelly, "Pentagon Backs Criticism of Airborne Laser," *Defense Week* (5 Apr 1999); Amy Svitak, "Airborne Laser May Lack Range Needed to Kill All Theater Missiles," *Inside the Air Force* (28 Apr 2000).

[147] "Boeing: Cuts to Airborne Laser Budget Could Delay IOC by Seven Years," *Inside the Air Force* (28 Jan 2000); Donnelly, "Pentagon Backs Criticism"; Tirpak, "Military Lasers High and Low," 52.

[148] Laurie Copans, "Israel to Use Laser Defense Against Rockets," *Boston Glove* (4 May 2000), 18; James Glanz, "Israeli-American Laser Passes a Missile Defense Test, U.S. Says," *New York Times* (4 May 2000); Janine Zacharia, "Anti-Katyusha Laser System to be Tested in Early June," *Jerusalem Post* (26 May 2000).

TMD Core Programs: PAC-3 and THAAD

The increased attention and most especially the increased funding led to progress with the missile systems. The baseline for this progress is most logically the Army's well-known Patriot system. The Army planned a number of incremental improvements of missile, launcher, and radar in order to field the PAC-3 (Patriot Advanced Capability) version. This began with a Quick Reaction Program that improved radar sensing (to permit discrimination between the target warhead and its debris) and remote launch capability (enabling the missiles to be emplaced up to 10km from the radar and control center) deployed in 1993. This increased the defended area, previously an area about 10 by 20km, by a factor of five. At about the same time, the developers were improving the missile with the Guidance Enhanced Missile (GEM). GEM included such changes as a lighter weight case and advanced propellants that increased range by 30 to 40 percent.
The Army began to deploy it and the next improvement, Configuration 1, that consisted of improved battle management, command, control, communications, and intelligence (BMC^3 I). In 1995 Raytheon also developed an improved multi-mode seeker for the missile.[149]

The most significant change was to replace the warhead. The existing Patriot missile with its blast fragmentation warhead and improved multi-mode seeker was matched against an entirely different warhead concept: "hit-to-kill." The Army had begun work on this idea, most notably in the Flexible Lightweight Agile Guided Experiment (FLAGE) in 1983, although it was not funded until 1987. In May of that year FLAGE successfully intercepted a Lance missile. Not only did FLAGE feature a different destruction mechanism, it was also notable because of its on-board radar and computer. The Army upgraded FLAGE, which extended the missile's range and speed in a follow-on design called Extended Range Intercept Technology (ERINT). It used a hit-to-kill mechanism along with a "lethality enhancer" that dispensed small pellets. The Loral-Vought missile flew a number of successful intercept tests during 1992-1994.

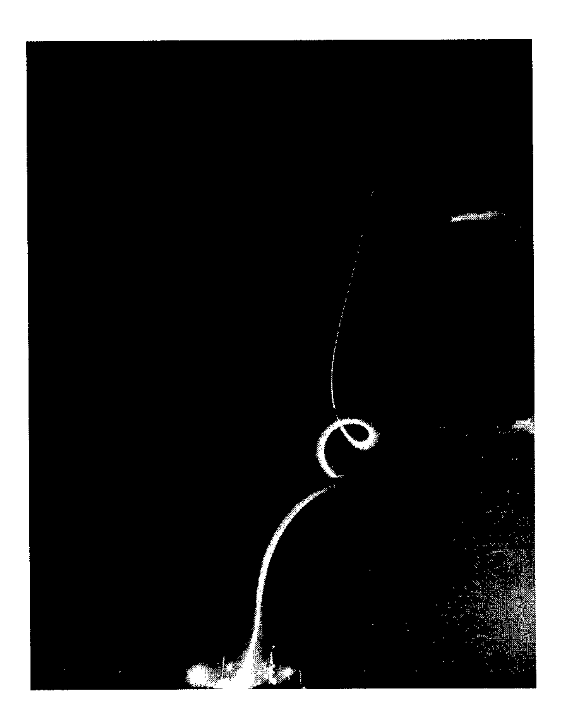
ERINT competed with the improved Patriot missile for use in the PAC-3 configuration. Although Raytheon's multi-mode seeker missile hit a Patriot acting as a target in July 1992, in early 1994 the Army picked ERINT as its PAC-3 missile. While the multi-mode seeker apparently performed better against cruise missiles, aircraft, and drones than did ERINT, the Army stated that ERINT had greater range, accuracy, and lethality. (One source claims it had about ten times the footprint of the PAC-2 system.[150] As it was considerably smaller than the previous Patriot missile (weighing 312kg at launch compared with the 1000kg), four could be fitted into each Patriot tube, so that 16 could be carried in lieu of 4 of the older missiles. Another advantage was that in simulated tests against biological and chemical warheads, ERINT destroyed 60 to 80

[149] BMDO, Fact Sheet, "Patriot Advanced Capabability-3," 1-2; Tony Cullen and Christopher Foss, eds., *Jane's Land-Based Air Defense, 9th Edition: 1996-97* (London: Jane's, 1996), 286; Falkenrath, "US and Ballistic Missile Defense," 18; Lisbeth Gronlund et. al., "The Weakest Line of Defense: Intercepting Ballistic Missiles," 57 in Joseph Cirincione and Frank von Hippel, "The Last Fifteen Minutes: Ballistic Missile Defense in Perspective," Coalition to Reduce Nuclear Dangers, 1996.

[150] Gronlund, "Weakest Line," 57.

percent while the multi-mode seeker claimed fewer than 10 percent. It had an expected IOC of late 1998 or 1999.[151] Thus American BMD warhead kill mechanisms evolved from nuclear, to blast-fragmentation, to hit-to-kill.

The PAC-3 program encountered scheduling delays, cost overruns, and technical challenges in the 1990s. By mid-1999 it was two years behind schedule and 37 percent over budget, about $278 million. But the PAC-3 did achieve testing success, scoring two successful interceptions, one in mid-March and the other in mid-September 1999. This encouraged the government to authorize limited low rate production of 92 missiles. The Army plans to achieve IOC in 2001. The full-scale plan calls for the purchase of 560 PAC-3s at a total program cost of $7.7 billion. The Army intends to keep the weapon in the inventory until 2025, with planned upgrades of ground equipment.[152]



THAAD maneuvering after launch. Credit: BMDO

A second core system is the Theater High Altitude Air Defense (THAAD) system. It is designed to engage targets at over 200 km range and 150 km in altitude

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[151] Cullen and Foss, *Jane's Land-Based Air Defence: 1996-97*, 209,284; Falkenrath, "US and Ballistic Missile Defense," 20-21; Schomisch, *1994/95 Guide to TMD*, 47,49,51; Walker, Martin, and Watkins, *Strategic Defense*, 99,102.

[152] Bradley Graham, "Army Hit in New Mexico Test Said to Bode Well For Missile Defense," *Washington Post* (16 Mar 1999), 7; "PAC-3 Missile Program Cost Overruns Soar to $278 Million," *Aerospace Daily* (18 Jun 1999); James Hackett, "Missile Defense Skeptical Revival," *Washington Times* (26 Aug 1999), 13; Robert Wall, "Missile Defense Changes Emerge," *Aviation Week and Space Technology* (30 Aug 1999), 30; "Lockheed's PAC-3 Knocks Down a Contract," *Baltimore Sun* (17 Sep 1999); Hunter Keeter, "PAC-3 Intercept Clears Way for LRIP Decision," *Defense Daily* (17 Sep 1999), 1.

giving it a footprint ten times the of the Patriot. In addition, it is designed to be air transportable in the C-130, and thus be more portable than the Patriot. It is a single stage missile about 6.2 meters long that weighs 600 kg less than the Patriot.[153] The missile's range and high speed will give it multi-shot engagement capability of the same target, that is, the ability to "shoot-look-shoot." Like the more recent US BMDs, it is armed with a hit-to-kill warhead. It uses radar early in the engagement, and then an infrared sensor and computer aboard the missile for interception.[154] The Army intends to mount ten THAAD missiles on a truck, and organize nine of these launchers into a battery. The Army plans a buy of 80 launchers and just under 1,300 missiles. Although the precise costs are elusive, it is an expensive system in the range of $10 to 15 billion. At one time the IOC was 2002, but in 1999 was given as 2007.[155]

THAAD began in 1988, with an award to Lockheed in September 1992. The concept was promising, but the effort has been difficult. A"nearly unending series of setbacks" marked its testing according to the *New York Times*.[156] Following its first flight in April 1995, THAAD attempted six interceptions without success. Clearly the program was in trouble, if not "floundering." Then the Army broke its losing streak when THAAD achieved its first interception in June 1999. This was a considerable achievement as the target, a modified Minuteman missile, was hit over 50 miles high and with a (combined) closing speed of 15,000 fps. The next test in August 1999 was another successful intercept.[157]

The THAAD path to deployment, however, was not yet assured. Despite this dramatic turn about, as late as the end of August 1999 one commentator, a contributing editor to the *Los Angeles Times*, wrote, "THAAD is the last pathetic residue of Ronald Reagan's grandiose Star Wars system, a fantasy...that was a stunning failure."[158] Nevertheless, or perhaps because of this kind of reaction, less than three weeks after the

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[153] Cullen and Foss, *Jane's Land-Based Air Defence, 1996-97*, 283; David Heebner, "An Overview of the U.S. DoD Theater Missile Defense Initiative," 53 in American Institute of Aeronatautics and Astronautics, *Theater Missile Defense: Systems and Issues—1993* (Washington: AIAA, 1993); Earl Ficken, "Tactical Ballistic Missile Defense: Have We Learned Our Lesson?," Air War College, Apr 1995, 21.

[154] Ballistic Missile Defense Organization, Fact Sheet, "Theater High Altitude Area Defense System," 2; Cullen and Foss, *Jane's Land-Based Air Defence 1996-97*, 284.

[155] Confusion over cost may be due to the inclusion/exclusion of the ground-based TMD-GBR sensor that will provide search and tracking information to the TMD. Cirincione and von Hippel, "Last 15 Minutes," 48; Cullen and Foss, *Jane's Land-Based Air Defence 1996-97*, 283-84; Government Accounting Office, *Theater Missile Defense Program: Funding and Personnel Requirements Are Not Fully Defined*, Dec 1992, 10-11; Bradley Graham, "Pentagon Gives THAAD a Boost," *Washington Post* (20 Aug 1999), 2; Joseph Peterson, "Theater Missile Defense: Beyond Patriot?," Naval Postgraduate School, Jun 1994, 97Schomish, *1994-95 Guide to TMD*, 250.

[156] William Broad, "New Anti-Missile System to be Tested this Week," *New York Times* (24 May 1999), 1; Walker, Martin, and Watkins, *Strategic Defense*, 103.

[157] Ballistic Missile Defense Organization, Fact Sheet, "Theater High Altitude Area Defense System," 1-2; Ballistic Missile Defense Organization, Fact Sheet, "Theater High Altitude Area Defense System Flight Test Program," 2-4; Bradley Graham, "Anti-Ballistic Missile Has 2nd Hit," *Washington Post* (3 Aug 1999), 6; James Hackett, "What the THAAD Hit Means," *Washington Times* (15 Jun 1999), 18; Robert Holzer, "U.S. Navy Rips Missile Merger," *Defense News* (8 Feb 1999), 3; Philip Shelton, "After Six Failures, Test on Antimissile System Succeeds," *New York Times* (11 Jun 1999).

[158] Robert Scheer, "Real Phantom Menace is Star Wars," *Los Angeles Times* (31 Aug 1999), 13.

second success, the Department of Defense (DoD) announced that the weapon would enter Engineering and Manufacturing Development (EMD) without further testing. This changed the earlier requirement (apparently valid at least into July), that a positive EMD decision would hinge on three successful intercepts. A few days later the top DoD tester, Philip Coyle the director of Operational Testing and Evaluation, stated that these successes were "not operationally realistic" and called for further testing. Coyle based his criticism on the facts that the missile used was not the one that would be fielded, the targets were employed over a shorter range than the system might face, and test conditions were contrived.[159]

Aside from the perennial technical and cost issues, THAAD had two other pressing problems. First, some assert it was in conflict with the 1972 ABM Treaty because of its speed, range, mobility, and its ability to process information from both ground and space-based sensors. The authorities recognized these problems and in December 1993 proposed amending the Treaty to permit THAAD testing. There was no agreement with the Russians, so the Administration declared THAAD Treaty compliant in January 1995, or more precisely, that it could be tested as it was not able to engage strategic missiles without space cueing.[160]

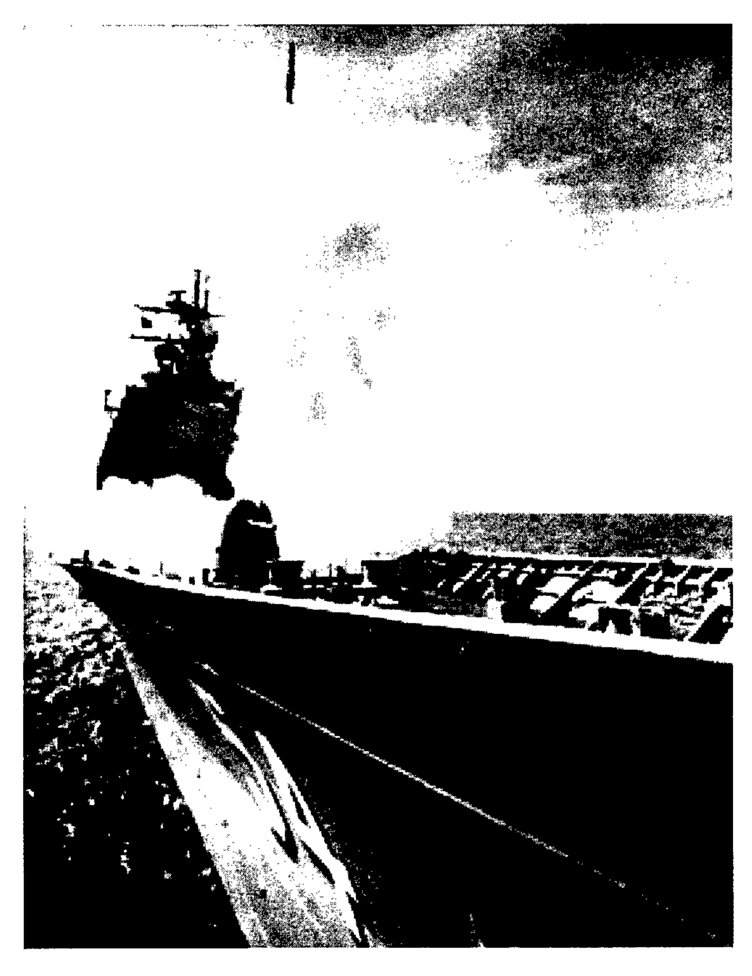
Navy programs

THAAD faced competition from a Navy BMD. The push for a nautical BMD had two roots. First, the navy required protection of its own assets from ballistic missiles and to provide cover for landing troops. Second, shipboard BMD would be mobile, permitting shifting of scarce resources and finessing diplomatic problems of basing rights and host country permission. Such mobility would represent a show-of-force and give the US considerable political/diplomatic leverage. There are two Navy projects under development: the lower tier Navy Area Defense (NAD) system and the upper tier Navy Theater Wide (NTW) system.

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[159] John Donnelly, "THAAD Intercepts Were Unrealistic, Top Tester Says," *Defense Daily* (23 Aug 1999), 1; Graham, "Pentagon Gives THAAD a Boost," 2; "THAAD Test Flight Pushed Back as Accelerated Development is Mulled," *Inside Missile Defense* (14 Jul 1999), 4.

[160] Gronlund, "Weakest Line," 59; Peterson, "Theater Missile Defense," 82; Walker, Martin, and Watkins, *Strategic Defense*, 103.



Navy Theater Ballistic Missile Defense. The Navy has a number of BMD programs. Credit: BMDO

The original concept was that the two American upper tier BMD systems, the Army (THAAD) and Navy programs, would compete, and that late in 2000 one project would receive priority (the majority of the money) in funding in fiscal year 2002 with the loser trailing along. THAAD was favored as it was further along in development than NTW, and the latter was also short of funds. This scheme was changed somewhat in December 1999. Then the trade press reported that DoD approved a plan to fully fund both projects through fiscal year 2005. The IOC remained at 2007, although the Army was pushing efforts to move this up one or two years.[161]

DoD considered a number of missiles for the system. The trade press reported that the DoD was considering standardizing on one missile for both the Army and Navy upper tier programs. Because of the status of the two programs, this would mean using the

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[161] The downside of this financial change was the expectation that inventories of two of the lower-tier system, PAC-3 and NAW would be reduced. Ballistic Missile Defense Organization, Fact Sheet, "Ballistic Missile Defense—The Core Programs," 2; John Donnelly, "Pentagon Plans $5 Billion for 'Upper-Tier' Missile Defense," *Defense Week* (20 Dec 1999), 1; Hunter Keeler, "BMDO Plans to Fully Fund Both Upper Tier TMD Systems," *Defense Daily* (15 Dec 1999), 1; "Special Defense Department Briefing with Defense Secretary William Cohen," *Federal News Service* (20 Jan 1999); "U.S. Army Mulls Faster THAAD Fielding with P3I Approach," *Aerospace Daily* (26 Aug 1999).

THAAD for both land-based and ship-based applications. While that might make economic sense, and perhaps technical sense, it had political problems. That is, Republican legislators, holding the majority in Congress in the late 1990s, strongly supported separate Army and Navy programs, as naturally did both two services.[162]

The present concept was to mate the Light Exoatmospheric Projectile (LEAP) to a new missile. LEAP began with a 220-pound device in August 1989, but within three years its weight had fallen in five various versions to between 12 and 40 pounds. It was estimated to have a maximum speed of 4.5 km per second, twice the speed of THAAD, and an altitude capability of 80km. LEAP had its first successful test in September 1992.[163]

The Navy is also working on a short-range BMD, NAD. It is based on the Navy's SM-2 Block IV A missile. Although the first test was slid seven months to May 2000, the first planned intercept test is scheduled for fiscal year 2001. The Navy plans to achieve IOC in fiscal year 2004. This system will offer protection against aircraft, cruise missiles, and short-range ballistic missiles. The program was experiencing significant cost problems.[164]

The NAD system would be based on the Standard missile that replaced the Terrier and Tartar missiles and be similar to the Army's Patriot. The modified Standard missile, known as one of the Navy's most reliable missiles, will be deployed aboard *Aegis* class cruisers and destroyers. It is another hit-to-kill missile fitted with an infrared sensor that successfully intercepted a Lance ballistic missile over 40,000 feet over the White Sands testing facility in January 1997. That same year the system entered EMD. The Navy completed sea trials in October 1998 and in September 1999 successfully flew the lower tier Standard 3 missile.

The increased funding for the Navy system will permit the modified SM-2 block I, the first long range version of the interceptor, to be deployed in fiscal year 2006. It will be capable of defending against the older, medium range tactical ballistic missiles, such as the longer-range (500-600km) Scud and Scud types. The block II version will counter the longer-range missiles.[165]

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[162] Donnelly, "Pentagon Plans $5 Billion," 1.

[163] Gronlund, "Weakest Line," 48; David Heebner, "An Overview of the U.S. DoD Theater Missile Defense Initiative," 56 in AIAA, *Theater Missile Defense 1993*; Peterson, "Theater Missile Defense," 72; Schomish, *1994/95 Guide toTMD*, 75,77; Simon Worden, "Technology and Theater Missile Defense," 94 in AIAA, *Theater Missile Defense 1993*.

[164] Peter Skibitski, "Navy Again Slides Date of First Area Anti-Ballistic Missile Shot, " *Inside the Navy* (13 Mar 2000).

[165] Ballistic Missile Defense Organization, "Fact Sheet: Ballistic Missile Defense—The Core Programs," 2; Ballistic Missile Defense Organization, "Fact Sheet: Navy Area Ballistic Missile Defense Program,1-2; John Carey, "Missile Shield from the Sea," *Defense News* (29 Mar 1999), 19; Donnelly, "Plans $5 Billion," 1; John Donnelly, "U.S., Japan to Ink Missile-Defense Deal," *Defense Week* (26 Jul 1999),1; Federation of Atomic Scientists, "Navy Area Defense (NAD) www.fas.org/spp/starwars/program/sm2.htm; "First National Missile Defense Intercept Test Slated for this Week," *Aerospace Daily* (29 Sep 1999); Robert Holzer, "U.S. Navy Missile Defense Effort Wins Support,"

The attractiveness of the Navy system was clearly evident in 1999. In September the Japanese signed a cooperative agreement with the US to conduct joint research for the NAD system. The intention is to jointly deploy a block II Standard, with (as of December 1999) an undetermined IOC. The next month naval representatives from the US, Australia, Germany, Italy, and the Netherlands met in separate meetings to investigate a future cooperative naval effort. British representatives joined representatives of these five countries in an April 2000 meeting on the subject.[166]

Other BMD Systems: HAWK, MEADS, and Arrow

The HAWK (Homing All The Way Killer) was a SAM designed to combat aircraft. It has been in the US inventory for some time, but by the 1990s gone out of service with the Army although it was still used by more than 15 countries as well as with the Marine Corps. The Marines lacked the Patriot and required a stopgap TMD until they fielded the Medium Extended Air Defense System (MEADS) in the 21st century. (Compared with the Patriot, the HAWK had a smaller footprint but was more mobile.) As early as 1988 the HAWK demonstrated BMD capabilities against a simulated ballistic missile target. The Army started efforts to modify it for the TMD role before passing the entire system along to the Marines in 1992.



HAWK. This early US surface-to-air missile, like most SAMs, has a limited ballistic missile defense capability. Credit. BMDO

Defense News (26 Jul 1999), 3; "US Navy Test Intercept Missile," Centre for Defence and International Security Studies, Back Issues: Jan '97 www.cdiss.org/97jan1.htm.

[166] Colin Clark and Robert Holzer, "U.S., Allies Move on Maritime TMD Partnership Plan," *Defense News* (29 Nov 1999), 1; Sandra Erwin, "U.S. Ponders Sea-Based Missile Defense," *National Defense* (Oct 1999), 25; Ann Roosevelt, "Allies Show Interest in Navy TBMD," *Defense Week* (24 Apr 2000), 5.

There were two principal modifications to enable the HAWK to provide BMD. The first permitted the radar to range out 400nm and up to 500,000 feet, and the second, increased the warhead size and used a new fuze. In May 1991 the system, cued by Patriot radar successfully intercepted a ballistic missile. In September 1994 the modified system, called Improved HAWK II, downed Lance ballistic missiles. Another development was to make the system interoperable with the upgraded Patriot system, allowing the HAWK to share data from the Patriot's more sophisticated and capable electronics. All of the Marine HAWKs were modified to this new standard by 1999.[167]

Meanwhile the Army realized it needed a better SAM, and sought a system with capabilities between that of the man-portable Stinger and the relatively static Patriot. The requirement was for a weapon to provide 360-degree protection with better range, mobility, and firepower than the HAWK, and greater mobility and survivability than the Patriot. (Another goal of the program was to reduce the manpower required to man the SAM battalion from 500 to about 300.) It began life called Corps Surface to Air Missile, a joint Army-Marine project intended to replace the HAWK. It soon became an international project when the Germans, then the French and Italians, joined the effort, formalized in a joint Statement of Intent signed in February 1995. At this point the project was renamed MEADS. When the French dropped out of the program in May 1996, the three remaining partners (US, Germany, and Italy) agreed to share the work and costs on a 60:25:15 percent basis.[168]

Mounted on a wheeled or tracked vehicle, MEADS featured both strategic and tactical mobility. Unlike the Patriot that required the C-5 for transport, MEADS will be transportable on the ever-present C-130; in fact this became the driving requirement. Toward this goal, Lockheed-Martin designed a lightweight launcher that weighed 16,000kg, less than half the weight of the 36,000kg Patriot launcher.[169] The US pushed to adopt the PAC-3 missile for the MEADS. This would certainly save money, always an important consideration, but caused some grumbling among the European partners who wanted a greater technology transfer. They also feared that the US was not fully supporting the program, as evidenced by the absence of long-term funding, a concern somewhat reduced by US budgeting action taken in mid-1999. As cost estimates fluctuated from the original $36 billion, developers pushed back the date of IOC back from the original 2007 to 2010.[170]

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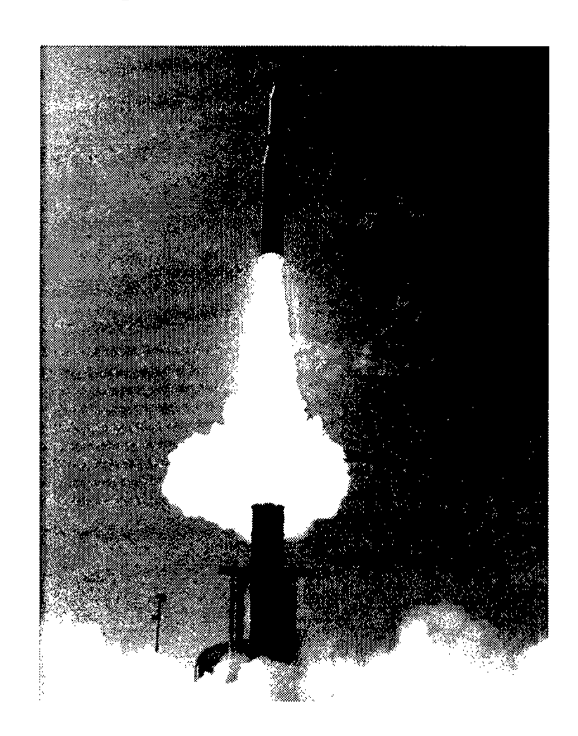
[167] Centre for Defence and International Security Studies, "Current and Near-Term Missile Defences," 3 www.cdiss.org/near1.htm; ; Cullen and Foss, *Jane's Land-Based Air Defence, 1996-97*, 289,293-95; Falkenrath, "US and Ballistic Missile Defense," 19; Federation of Atomic Scientists, "HAWK," 1-2 www.fas.org/spp/starwars/program/ hawk.htm .

[168] BMDO, Fact Sheet, "Medium Extended Air Defense System," 1-2; CDISS, "US-Allied Co Operation," 3.

[169] BMDO, Fact Sheet, "MEADS,"1; Federation of Atomic Scientists, "Medium Extended Air Defense System (MEADS) Corps SAM," 1 www.fas.org/spp/starwars/program/ meads.htm; Cullen and Foss, *Jane's Land-Based Air Defence,1996-97*, 292; Ramon Lopez, Andy Nativi, and Andrew Doyle, "The Need for MEADS," *Flight International* (17-23 Mar 1999), 34; Schomish, *1994/95 Guide toTMD*, 78.

[170] BMDO, "Fact Sheet MEADS," 2; Cullen and Foss, *Jane's Land-Based Air Defence, 1996-97*, 292; Gronlund, "Weakest Line," 47; Lopez, Nativi, and Doyle, "Need for MEADS," 34; Greg Seigle, "US Spending Row Puts MEADS in Jeopardy," *Jane's Defence Weekly* (25 Aug 1999); Robert Wall, "Missile Defense Changes Emerge," *Aviation Week and Space Technology* (30 Aug 1999), 30.

In May 1999 the three-government consortium awarded an international partnership (Euro MEADS and the American Lockheed-Martin) the MEADS contract. This surprised some observers in view of the latter company's difficulties with the THAAD program. As the Americans desired, the missile will be based on the PAC-3 missile as a cost saving measure. The hope is that this will reduce the $5 billion missile development program by half. MEADS will be a versatile weapon, able to intercept ballistic missiles, manned, and unmanned vehicles.[171]



Arrow. The US and Israeli governments jointly developed this theater ballistic missile defense. The Israelis stated that it was put into operations early in 2000. Credit: BMDO

Another missile system under development to fulfill the TMD role is the Israeli Arrow. The Israelis began work on the project in 1986 and gained US support two years later. This unusual weapons development relationship, well beyond the scope of this study, has much to do with the US-Israeli "special relationship." According to a Ballistic Missile Defense Organization public release, "Israel and the U.S. have a strong history of ballistic missile defense (BMD) cooperation, including cooperation on a testbed and related experiments, and TMD architecture studies."[172] As of 1993 the US had funded 78 percent of the missile's development directly, and another 20 percent more through foreign aid. The Israelis funded the early warning and fire-control system. Late in 1999 the total cost was about $1.1 billion.[173]

The Arrow had a considerable number of technical problems. In the period 1988 through 1991 its record was called "disappointing." While it scored several successes in simulated intercepts in the 1990s, it was not until November 1999 that it achieved its first actual interception, when it hit an earlier generation Arrow at about a 30-mile range and 25 mile altitude.[174] The Arrow was designed to have a footprint larger than that of the

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[171] Muradian, "Lockheed Martin Beats Raytheon."

[172] Ballistic Missile Defense Organization, Fact Sheet, "Arrow Deployability Program," 1; General Accounting Office, *U.S. Israel Arrow/ACES Program: Cost, Technical, Proliferation, and Management Concerns*, Aug 1993, 1-2.

[173] GAO, *US Israel Arrow*, 1-2; Arieh O'Sullivan, "Final Arrow Test to be Held Soon," *Jerusalem Post* (22 Oct 1999); Arieh O'Sullivan, "Air Force Welcomes Arrow 2," *Jerusalem Post* (15 Mar 2000).

[174] BMDO, "Fact Sheet Arrow Deployability," 1; Steven Hildreth, "Theater Ballistic Missile Defense Policy, Missions and Program: Current Status," Congressional Research Service, Jun 1993, 30; William Orme, "In Major Test, New Israeli Missile Destroys 'Incoming' Rocket," *New York Times* (2 Nov 1999);

PAC-3 (one Arrow battery could cover as much as four Patriot batteries according to one secondary source) but smaller than that of the THAAD. There are also claims that the Arrow's infrared sensors are 18 months ahead of those in the American THAAD program. It was capable of a speed of Mach 9.0 and ranges between 16 and 48km and altitudes between 10 and 40km. Less mobile than the Patriot, it used a blast-fragmentation warhead to destroy its target.[175] The Israelis formally put the system in operation in May 2000 with full operations scheduled by year's end. They intend to field three batteries with an overall program cost in the range of $2 to 10 billion.[176]

A New Threat

One reason for this increased BMD activity was the recognition of an increased threat. Following the collapse of the Soviet Union and the overwhelming military victory in the Gulf War in the early 1990s, Americans relaxed believing they were secure. The US was clearly the one superpower if not (as the French exclaimed) a "hyperpower." These victories, the lack of a clear threat, and political rhetoric brought the American public the expectations of a "peace dividend." Thus military funding was cut as the government, both the Executive and Legislative branches turned their attention elsewhere. The politicians were also lulled by a 1995 National Intelligence Estimate and the intelligence community's March 1998 annual report that held that it would take 15 years for a country without a ballistic missile infrastructure to deploy such weapons.[177] This would give the US at least five years warning before such a deployment. Critics noted that this attitude, welcomed by the Clinton Administration, ignored the existing Russian and Chinese ICBMs, turned a blind eye to the vulnerability of Alaska and Hawaii, and disregarded missile and missile technology transfer. Perhaps even more important, it put a great burden on intelligence services.

Events in the summer of 1998 jarred this complacent view. First, a congressionally mandated committee chaired by former Secretary of Defense Donald Rumsfeld presented a contrary and disturbing report in July. It stated "that the threat to the United States from emerging ballistic missile capabilities is broader, more mature and is evolving more rapidly than contained in earlier estimates and reports by the U.S. intelligence community."[178] The committee specifically pointed at North Korea, asserting that "a fairly significant ballistic missile threat is emerging almost overnight in North Korea."[179] Not only did the North Koreans have such dangerous technology, but along with China and Russia, were exporting it to other nations such as Iran, Iraq, Libya,

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Schomish, *1994/95 Guide to TMD*, 125; Greg Seigle, "Confidence Over US-Israeli Target Test of Arrow 2," *Jane's Defence Weekly* (20 Oct 1999).

[175] BMDO, "Fact Sheet Arrow Deployability," 2; Schomish, *1994/95 Guide to Theater Ballistic Missile Defense*, 124-25; Seigle, "Confidence Over US-Israeli Target Test".

[176] Hildreth, "Theater Ballistic Missile Defense Policy," 30; "The Arrow Shield," *Jerusalem Post* (16 Mar 2000); Orme, "In Major Test"; William Orme, "Israel: Missile Defense Deploys," *New York Times* (15 Mar 2000), A6; Schomish, *1994/95 Guide toTMD*, 125.

[177] This reminds historically minded individuals of the interwar British "ten year rule" that justified minimal defense budgets.

[178] Quoted in Clarence Robinson, "Missile Technology Access Emboldens Rogue Nations," *Signal* (Apr 1999); James Hackett, "CIA Candor on Missile Threat," *Washington Times* (20 Sep 1999), 19.

[179] Robinson, "Missile Technology Access."

Pakistan, and Syria. As some of these countries were making efforts to develop nuclear and biological weapons, and all had chemical capabilities, the threat was obvious.[180]

The Administration countered these dire warnings with a letter at the end of August from the top US military leader, Chairman of the Joint Chiefs of Staff (JCS), General Hugh Shelton to Senator James Inhofe (R-OK). The four-star general wrote that the JCS "remain[s] confident that the Intelligence community can provide the necessary warning of the indigenous development and deployment by a rogue state of an ICBM threat to the United States."[181] Shelton further claimed that it was unlikely for such nations to acquire ICBMs in short order without detection by intelligence. A greater problem, in his opinion, was the threat of weapons of mass destruction through terrorist attack. He held that the current defense policy was prudent and that continued adherence to the 1972 ABM Treaty was "consistent with our national interests."[182]

Events were not kind to either General Shelton or to the Administration's course of action. A week after Shelton's letter to Senator Inhofe, the North Koreans fired a three-stage missile (Taepo Dong 2) eastward, with the second stage landing east of Japan and the third stage near Alaska. With this lone missile, North Korea, a failed state that was unable to feed its people, demonstrated alarming and advanced technological and military capabilities. The surprise was more than just the North Korean ability to toss warheads great distances. The multi-stage missile showed a high level of technical competence, as did the fact that the third stage was powered by solid propellants. Particularly disturbing, until this demonstration North Korean expertise with solid fuels was unknown to US intelligence agencies. The Taepo Dong-1 missile with 1,200-mile range could hit targets in South Korea and Japan. The Taepo Dong 2 had a nominal range of 3,700 miles which put Alaska and Hawaii within its reach. Lighter versions of that missile could fly as far as 6,200 miles, threatening the western US.[183]

The problem was not only that hostile nations would develop ballistic missile and NBC capabilities on their own, but that they would be able to import what they wanted from other countries, specifically China, North Korea, and Russia. For example, on 22 July 1998 the Iranians test fired their 800-mile range Shahab-3 missile that is based on the North Korean No Dong. Russian engineers apparently are important in the development of Iran's successor missile, the 1,300-mile range Shahab-4 that will put southern and central Europe within reach of Iranian missiles. In addition to assistance from North Korea and Russia on their ballistic missile program, Iran may also have

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[180] Robinson, "Missile Technology Access."

[181] Quoted in "Missile Controversies," *Air Force Magazine* (Jan 1999), 50. A "rogue" state is a relative term applied in the early 21st Century to states seen by the US as outside the norms of international practices, for example sponsoring terrorism, flaunting international treaties and the like. It is clearly a pejorative term.

[182] "Missile Controversies," 50.

[183] John Donnelly, "Iran Has Makings of North Korea's Taepo Dong," *Defense Week* (24 May 1999),1; Jim Lea, "Report: N. Korea Using Japanese Technology for Developing Missiles," *Pacific Stars and Stripes* (20 Feb 1999), 3; Jim Lea, "ROK Won't Join Missile Program," *Pacific Stars and Stripes* (5 May 1999), 3; Robinson, "Missile Technology Access."

gotten help from China. Nuclear and missiles tests in 1998 and 1999 by India and Pakistan further demonstrated the problem.[184]

The effects cascade. According to a press report in November 1999, the Iranians have sold Scuds to the Democratic Republic of Congo. This not only highlights the fact that Third World countries judge ballistic missiles of considerable value, but also that ballistic missiles have spread to southern Africa, and that countries that have recently acquired this technology, in turn become sources to other countries. It also magnifies fears that internal conflicts could spread into regional ones.[185] The Central Intelligence Agency (CIA) acknowledged this situation in 1999. In February, CIA director, George Tenet testified to Congress that the increased range of ballistic missiles was "an immediate and growing threat."[186] Further, in September 1999 CIA missile specialist, Robert Walpole, stated that "Theater-range missile already in hostile hands pose an immediate threat to US interests, military forces, and allies. The threat is increasing."[187]

Some dispute the seriousness of the ballistic missile threat. They believe that while there clearly was a NBC threat, third world countries so inclined would use cheaper, less visible delivery systems than ballistic missiles. Further, they assert that nuclear deterrence will work as it did during the Cold War. BMD supporters counter that the rogue states of concern were not rational, and thus traditional deterrence could not be relied on. (For example, North Korea was building nuclear weapons and ballistic missiles while its population literally starved, while Iraq would not take measures to end an economic embargo while its population suffered.) In addition, there were fears that the very deployment of ballistic missiles armed with NBC warheads by a hostile power would cause profound effects upon a nation unprotected by BMD, specifically deter action.

In any case, these events seemed to galvanize decision makers. The Japanese were markedly affected. Since 1945 they have been bound both psychologically and politically by a "no war" attitude that led to a miniscule rate (less than 1 percent of the GNP) of spending on defense, and such contortions as calling their military a "Self Defense Force." Although the Japanese had been importing sophisticated US military technology such as the PAC-3, *Aegis* warships, and AWACS, they showed considerable reluctance over the BMD. They had a bad experience in the area of technology transfer when the 1989 deal over the F-16 blew up in everyone's face. While the Japanese military and elements of the government supported a move toward Japanese-US cooperation on BMD, Japanese industry and the powerful Ministry of International Trade and Industry questioned such an action. However, events in both China and North Korea led to an increase in Japanese military spending and a rise in funding for ballistic missile defense

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[184] Donnelly, "Iran Has Makings"; James Hackett, "Growing Missile Threat from Iran," *Washington Times* (2 Mar 1999), 13; Robinson, "Missile Technology Access."

[185] Bill Gertz, "Iran Sold Scud Missiles to Congolese," *Washington Times* (22 Nov 1999), 1.

[186] Quoted in Ralph Bennett, "Needed: Missile Defense," *Reader's Digest* (Jul 1999).

[187] Quoted in "Missile Controversies," 50.

by the end of 1999. In August 1999, the Japanese and Americans signed an agreement to conduct joint research on a BMD system.[188]

In contrast to the Japanese who showed uncharacteristic concern over these developments in North Korea, South Korea seemed unconcerned. This is remarkable in view of the closer South Korean geographic, emotional, and political proximity to the threat. The South Korean Defense Ministry stated that it would not join the joint American-Japanese ABM program, citing a lack of money and technology. Despite US efforts to include the South Koreans in the program, the South Koreans agreed to nothing more than talks on the subject. On their part, the South Koreans want to modify a 20-year old agreement with the US confining them to surface-to-surface missiles with ranges less than 180km. They want the ability to field missiles with ranges of 500km that would enable them to reach all of North Korea. The South Koreans apparently have more confidence in deterring the North Koreans than does the United States.[189]

Unlike the South Koreans, the government of Taiwan very much wanted BMD. In March 1999 they announced a $9 billion program over a ten-year period to develop a low-altitude air defense system. At the same time there was intense speculation that the Taiwanese wanted to get under the US-Japanese BMD umbrella. This effort was aided by the US Congress that requested the DoD study a defensive arrangement with Taiwan. In June 1999 Taiwan's President made clear that his country wanted to join the theater ballistic missile defense program.[190]

The American BMD agreement with Japan, and the prospects of a system that would potentially protect US forces and Allies in east Asia upset both China and North Korea. China was especially exercised as Taiwan is a particular sore point. The timing was unfortunate for both the US and China, inhibiting, if not preventing, either to act rationally or constructively. The BMD issue rose to prominence after US intervention in Kosovo and the bombing of the Chinese Embassy in Belgrade, Chinese grievances. At the same time there were growing American concerns with China on a number of matters. These included human rights violations, a mounting trade imbalance, threats aimed at Taiwan, illegal campaign funds in the 1996 US presidential elections, export of nuclear and missile technology, and allegations of espionage. The fear is that the deployment of a BMD system will further exacerbate US-Chinese relations, ignite an arms race in east and south Asia, encourage Chinese hard-liners, and lead to Chinese

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[188] "Budget Rise Sought to Cover Missile Shield," *South China Morning Post* (21 Dec 1999); Steven Hildreth and Gary Pagliano, "Theater Missile Defense and Technology Cooperation: Implications for the U.S.-Japan Relationship," Congressional Research Service, Aug 1995; Calvin Sims, "U.S. and Japan Agree to Joint Research on Missile Defense," *New York Times* (17 Aug 1999).

[189] Lea, "ROK Won't Join"; Don Kirk, "U.S. and Japan to Join in Missile Defense to Meet Pyongyang Threat," *International Herald Tribune* (29 Jul 1999).

[190] Vanessa Guest, "Missile Defense is Wrong Call on Taiwan," *Los Angeles Times* (3 May 1999), 17; "Missile Defense System Necessary: Lee," *South China Morning Post* (25 Jun 1999); "Taiwan Plans to Buy Missile Defense," *Washington Post* (26 Mar 1999), 22.

expansion of their limited ICBM force.[191] Often forgotten, is that these dire results may occur regardless of what happens with the US BMD system.

America's European Allies also criticized the American effort. NATO was slow in responding to the ballistic missile threat, with some Americans suspecting that the Europeans were again depending on the US to do the heavy lifting and paying the bills. At the same time, the Europeans had objections directed at both process and substance. They saw the NMD issue as another example of American unilateralism and arrogance, not consultation and agreement between Allies. More serious, they feared the impact of a US NMD deployment would decouple the US from Europe, as the partners would no longer face a shared nuclear risk. This, they postulated, would reinforce the ever-present American isolationist sentiment and lead to a "fortress America" attitude and action. There is also European concern that such a system would siphon off money from more pressing defense needs. Little wonder, then, that the European allies oppose the American program. In the words of one journalist, "The Clinton Administration's push for an anti-missile shield to protect U.S. territory is prying apart the Western alliance and laying bare the fragility of the allied consensus on security policy."[192] A prestigious London think tank, International Institute for Strategic Studies, was even sharper in its criticism. It asserted that the US path was causing "damage" and "disarray" in NATO ranks that could lead to "profound consequences." In its words, NMD was not only technically unproven, it was "an unnecessary, destabilizing move to counter an exaggerated threat."[193]

The chief European complaint appears to center on the impact of the American NMD on the 1972 ABM Treaty. They believe that a modification of this agreement and development of the NMD would probably encourage, if not force the Russians to build up their offensive and defensive forces that would nullify the deterrent forces of both Britain and France and lead to an arms race with China and Russia.[194] The view that the ABM Treaty is critical, was advanced by a United Nations General Assembly resolution in January 2000 that called for the treaty to be preserved and strengthened. UN Secretary General Kofi Annan went even further, warning that an American NMD deployment

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[191] "Budget Rise Sought"; Guest, "Missile Defense is Wrong Call"; "Taiwan Plans to Buy Missile Defense"; Paul Mann, "Missile Defense Gains Political Favor Amid Rifts," *Aviation Week and Space Technology* (1 May 1999), 51; George Melloan, "With Clinton in Check, China Flexes Its Muscles," *Wall Street Journal* (9 Mar 1999).

[192] Joseph Fitchett, "Washington's Pursuit of Missile Defense Drives Wedge in NATO," *International Herald Tribune* (15 Feb 2000); William Drozdiak, "Worries Mount in Europe Over U.S. Missile Defense," *Washington Post* (19 May 2000).

[193] Roy Gutman, "Institute Blasts U.S. Defense Plan," *Long Island Newsday* (7 May 2000).

[194] Elizabeth Becker, "Allies Fear U.S. Project May Renew Arms Race," *New York Times* (20 Nov 1999), 5; Clifford Beal, "Racing to Meet the Ballistic Missile Threat," *International Defense Review* (Mar 1993), 211; William Drozdiak, "Possible U.S. Missile Shield Alarms Europe," *Washington Post* (6 Nov 1999), 1; "Experts: U.S., Europe Far Apart on Response to Ballistic Missile Threat," *Inside Missile Defense* (14 Jul 1999), 1; Jane Perlez, "U.S. Missile Plan Could Hurt Security Ties, European Says," *New York Times* (2 May 2000); Schomish, *1994/95 Guide to TMD*, 99.

"could well lead to a new arms race."[195] These advocates believed that the solution to the problem of nuclear-armed missiles was not technology, but diplomacy centering on the 1972 ABM Treaty and the various SALT agreements that limited both defensive and offensive systems. They insisted that the ABM Treaty had to be maintained to achieve arms reduction.

At the same time, technical and political changes were buffeting the Treaty.[196] In December 1993 the US proposed modifications to the agreement to clarify testing of BMDs in what some perceived of as being in the "gray" area. The Treaty permitted defense geared against tactical ballistic missiles, but not those against strategic missiles. The negotiators, however, had not defined these terms. For years the US had informally used the so-called "Foster Box" concept that required approval by a Treaty Compliance Panel for American BMD tests against targets exceeding 2 km per second and an intercept altitude of 40km. Using this concept as a basis, the US proposed setting an upper limit on both target speed and range against which the systems could be tested, specifically 5 km per second in speed and 3,500 km in range. (ICBMs have a speed of 7 km per second and a 10,000km range, while tactical ballistic missiles have speeds around 2 km per second.)[197] The Russians were willing to accept the target speed limit, but also wanted to restrict the interceptor missile to a maximum speed of 3km per second. In May 1995 the two nations agreed to this arrangement.[198]

But this was about the only concession the Clinton Administration made toward deploying or developing the NMD. Earlier in a September 1993 five-year review of the Treaty, the Administration removed some of the changes proposed by the previous administration, for example, 150 interceptors and five additional launch sites. As already noted above, despite the mounting pressure for a NMD system, in 1996 Clinton responded to congressional pressure for NMD with a veto.[199]

Events, however, tilted the balance against the Treaty. This is perhaps most vividly summed up in an early 1999 Boston newspaper editorial. "The ABM treaty," it opined, "had become almost an object of worship by the arms control priesthood so prominent in the Clinton White House,... the Democratic Party,... and among liberals generally. But theology is no defense against a bold Chinese leadership or a crazy North Korean dictator."[200] The proliferation of missiles and NBC weapons, concerns with a number of countries, and domestic politics (fear that the Republicans would use NMD as

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[195] Carla Robbins and Greg Jaffe, "White House Missile-Defense Program Would Cost $60 Billion, Report Says," *Wall Street Journal* (25 Apr 2000); Barbara Crossette, "At U.N., Russia Hardens Line on Changes to Missile Treaty," *New York Times* (26 Apr 2000).

[196] There were allegations of Soviet cheating on the Treaty. While most of these cases fell into the gray category, matters that lawyers can argue endlessly over, the Soviet Foreign Minister Eduard Shevardnadze admitted in October 1989 that the radar installation at Krasnoyarsk was in violation of the Treaty. Bennett, "Needed: Missile Defense."

[197] Falkenrath, "US and Ballistic Missile Defense," 37,39; Gronlund, "Weakest Line," 59.

[198] Gronlund, "Weakest Line," 59.

[199] Missile Defense," *Kansas City Star* (24 Jan 1999), K2; Schomish, *1994/95 Guide to TMD*, 24.

[200] "Missile Job Not Finished," *The Boston Herald* (20 Mar 1999), 14.

an issue in the 2000 elections) forced the Administration to made key concessions, if not to abjectly capitulate to NMD proponents.

In January 1999 Secretary of Defense William Cohen ran up the white flag when he announced a $6.6 billion, five-year program to develop a NMD system, added to almost $4 billion already budgeted. Cohen also declared that the US was seeking changes in the ABM Treaty that would permit deployment of a restricted NMD, and added that without such amendments, the US might withdraw from the Treaty. This announcement "angered the Russians, dismayed arms control advocates and spurred new efforts by congressional hawks to abandon the 1972 Anti-Ballistic Missile (ABM) Treaty, which they believe inhibits U.S. ability to protect itself against a growing missile threat."[201]

At the same time, the Administration attempted to reassure the Russians and arms control supporters. Within hours of Cohen's remarks, top Administration officials "clarified" them, or, according to the hawkish *Washington Times*, repudiated his statement. Among those named by the newspaper as deviating from Cohen's position were such influential administration leaders as Secretary of State Madeleine Albright and the President's national security advisor Samuel Berger. Berger strongly caveated Administration support for NMD deployment citing such considerations as technology, operational effectiveness, the threat, and arms control considerations. Deputy Secretary of State Strobe Talbott described the Treaty as the "bedrock"of US strategic policy while presidential spokesman Joe Lockhart used similar terms, calling the Treaty "the cornerstone of our strategic strategy."[202] The US attempted to convince the Russians to agree to Treaty modifications, and went as far as to offer US financial support to finish one important radar installation in Siberia and upgrade a second one in Azerbaijan, an offer that thus far the Russians have rejected. The US offered to share BMD technology with the Russians, first under Reagan and then Bush. In May 2000 Clinton stated he would be willing to share BMD technology with allies and possibly with the Russians. At the same time President Putin suggested that the two countries collaborate on such a project. The US was seeking two changes in the Treaty, to increase the number of permitted sites to two and to install one of these in Alaska. But aside from Putin's suggestion, there was no indication that the Russians were willing to amend the ABM Treaty.[203]

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[201] Thomas Lippman, "New Missile Defense Plan Ignites Post-Cold War Arms Debate," *Washington Post* (14 Feb 1999), 2; Steven Myers, "U.S. Asking Russia to Ease the Pact on Missile Defense," *New York Times* (21 Jan 1999), 1.

[202] Sheila Foote, "White House Threatens Veto of Cochran's NMD Bill," *Defense Daily* (5 Feb 1999), 1; Lippman, "New Missile Defense Plan"; Bill Gertz, "U.S. Missile Plan Hits Roadblock," *Washington Times* (22 Oct 1999), 1; Frank Gaffney, "What ABM Treaty?," *Washington Times* (4 Mar 1999), 17; Bradley Graham, "U.S. to go Slowly on Treaty," *Washington Post* (8 Sep 1999), 12; Jonathan Weisman, "U.S., Russia to Develop a Joint Missile Defense," *Baltimore Sun* (1 Aug 1999).

[203] Charles Babington, "U.S. Set To Share Missile-Research," *Washington Post* (1 Jun 2000); Justin Brown, "Global Arms Race Turns Defensive," *Christian Science Monitor* (5 Jun 2000); Michael Gordon, "U.S. Seeking to Renegotiate a Landmark Missile Treaty," *New York Times* (17 Oct 1999), 1; Graham, "U.S. To Go Slowly on Treaty," 13; Jane Perlez, "Russian Aide Opens Door a Bit to U.S. Bid for Missile Defense," *New York Times* (19 Feb 2000; "Russia: Talks with U.S.," *New York Times* (23 Dec 1999), A8; "Russia Rejects Changes in ABM Treaty," *Washington Post* (4 Mar 2000), 14; Weisman, "U.S., Russia to

As the US and Russia approached the June 2000 summit, the last for outgoing President Clinton and the first for the newly elected Vladimir Putin, the two countries engaged in diplomatic maneuvering. Reportedly the Russians proposed to help restrain North Korea's missile program diplomatically, in exchange for keeping the 1972 ABM intact. The Russians fear that NMD would threaten nuclear deterrence and open an area of military competition in which the Russians could not afford economically to complete. They warned, however, that they would respond to NMD by abandoning all arms control measures, thus threatening to build rather than curtail the Russian nuclear offensive arsenal.[204]

The Russians also held out a carrot. In March 2000 Putin got the Russian Duma to ratify the 1973 START II Treaty that would reduce the two country's nuclear warhead count from 7,500 Russian and 6,400 US to between 3,000 and 3,500 by 2007. There was talk of even further cuts of the two arsenals to 1,500.[205]

On his part, Clinton made clear that he would approve NMD if it meet four criteria. These included affordable cost, a real threat, workable technology, and tolerable diplomatic impact.[206] All were of course open to wide interpretations. For example, what cost is tolerable? How much is it worth to save a number of American cities, or for that matter, one American city? What measure will define "workable technology"? That is, how well must the system work? Must it be 100 percent effective, if not, what is an acceptable effectiveness? Similarly, the appraisals of threat and diplomatic impact are subject to considerable subjective judgment.

Nevertheless Clinton bent to the domestic political realities as the Congress passed a veto proof National Missile Defense bill in March 1999. In July Clinton signed the measure that called for a national NMD as soon as technically feasible. The hard and fast decision was scheduled to be made in June 2000, although it appeared to be a mere formality in view of the upcoming presidential election. (The Democratic Administration feared lack of action on NMD would give the Republicans a potent campaign issue.)[207]

In late December 1999, however, the conservative *Washington Times* wrote that some believed Clinton would forgo a decision on NMD deployment in June 2000 and instead pass the hot potato on to his successor. In early 2000 a number of influential individuals called for a delay in this decision. These included the ranking minority member of the Senate Foreign Relations Committee, a number of Republican Senators, and the well-known and respected former Secretary of State and foreign policy expert,

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Develop a Joint Missile Defense"; Office of the Assistant Secretary of Defense (PA), New Briefing, 1 Jun 2000.

[204] Walter Pincus, "Russia Has Offer on Missile Defense," *Washington Post* (29 Apr 2000); Mark Thompson and Douglas Waller, "Shield of Dreams," *Time* (8 May 2000).

[205] Dave Boyer, "GOP Tells Russians Missile Defense A Go," *Washington Times* (3 May 2000); Thompson and Waller, "Shield of Dreams"; Jonathan Alter, "Swords Vs. Shields," *Newsweek* (8 May 2000).

[206] Mary McGrory, "Going Ballistic," *Washington Post* (30 Mar 2000).

[207] Bennett, "Needed: Missile Defense"; David Sands, "U.S. Considers Placing Missiles at Alaska Sites," *Washington Times* (9 Sep 1999), 17.

Henry Kissinger. Meanwhile the 2000 presidential nomination process in essence selected candidates who weighed in on the issue. The Republican, George W. Bush, proposed support for not one, but two missile defense systems (NMD and TMD) at the earliest possible date. His opponent, Democrat Al Gore, was more cautious. He supported the NMD concept but would not deploy the system until after further testing, talks with the Russians, and international approval.[208] As one journalists saw it, "The basic difference between the two presidential contenders is that Bush views the threat as already existing, while Gore still sees it as an open question."[209]

Then in late March 2000 the decision timetable was extended. The military postponed the critical third missile test two months until late June, which they admitted was "exceptionally hurried." This meant that evaluation would not come until a month later, and the President's decision at the end of October. Because of the harsh Alaskan climate, this was the latest possible time the decision could be made if construction were to begin the next spring and meet the IOC planned for 2005.[210] The plan's first phase called for missiles sited in the interior of Alaska and a new radar on the Alaskan island of Shemya (at the far west on the Aleutian chain), with 20 missiles operational by 2005 and all 100 by 2007. Other changes that the US desired in the 1972 ABM Treaty would permit upgrades of radars in Alaska, Massachusetts, and California. The second phase would expand the radar system. In the third, the US would add a second site in North Dakota with 150 missiles.[211] The government believed that 20 interceptors could handle five ICBMs each fitted with a warhead and simple decoys, and 100 interceptors could handle 25 ICBMs each with a single warhead and simple decoys. The larger defensive force could also handle five ICBMs that each carried five warheads and 20 sophisticated decoys.[212]

Some fervent NMD proponents feared that Clinton would opt for a minimal system and cut off the possibilities of a more robust one. In mid-April 2000 25 Republican Senators sent a letter to the President that stated their opposition to a revised ABM Treaty that limited a future US national missile defense. This was a potent threat as treaty ratification required a two-thirds vote of the Senate. The situation was further

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[208] Elizabeth Becker and Eric Schmitt, "Delay Sought in Decision on Missile Defense," *New York Times* (20 Jan 2000); Justin Brown, "Two Views of Security, as Seen in 'Star Wars,'" *Christian Science Monitor* (13 Mar 2000); Bradley Graham, "Missile Shield Still Drawing Friends, Fire," *Washington Post* (17 Jan 2000); James Hackett, "Sorties Against Missile Defenses," *Washington Times* (27 Dec 1999); Jane Perlez, "Biden Joins G.O.P. in Call for a Delay in Missile-Defense Plan," *New York Times* (9 Mar 2000).

[209] Leo Rennert, "Missile Defense Tops National Security Debate," *Minneapolis Star Tribune* (22 May 2000).

[210] Elizabeth Becker, "Pentagon Delays Test of Defense Using Missiles," *New York Times* (22 Mar 2000); Roberto Suro, "Missile Defense Test Postponed," *Washington Post* (21 Mar 2000). In May the "decisive" test was again delayed a week or longer. Pentagon spokesman claimed this would have no impact on the decision time table. Steven Meyers, "New Delay fo Test of U.S. Ballistic Missile Defense System," *New York Times* (19 May 2000).

[211] Becker, "Pentagon Delays Test"; Martha Bristow, "Missile Defense Head Says Greely Still Top Choice," *Fairbanks Daily News-Miner* (3 May 2000); Steven Myers and Jane Perlez, "Documents Detail U.S. Plan to Alter '72 Missile Treaty," *New York Times* (28 Apr 2000); "Misdirected Missile Defense Plan," *Los Angeles Times* (30 Apr 2000).

[212] Federation of Atomic Scientists, "National Missile Defense," 5.

compounded a few days later when long-time Clinton foe and chairman of the crucial Senate Foreign Relations Committee, Jesse Helms, stated that he would block any arms-control agreement the lame-duck administration brought forward, calling it "dead on arrival."[213] Helms asserted that "After dragging his feet on missile defense for nearly eight years, Mr. Clinton now fervently hopes that he will be permitted, in his final months in office to tie the hands of the next President. He believes he will be allowed to constrain the next Administration from pursuing a real national missile defense." The influential Senator stated in no uncertain terms, "Well, I for one have a message for the President: Not on my watch, Mr. President. Not on my watch!"[214] This was the situation as Clinton and Putin were poised to meet.

As throughout its history, opponents of BMD raised technical objections. These centered on the ease by which an attacker could deceive, or overwhelm, the system using relatively simple decoys. A new issue was to point out that the actual booster for the missile would not be tested until after the system was deployed. The critics noted that this booster would produce ten times the high-frequency vibrations as the test system, and, according to a Congressional Budget Office study, "distort or damage the kill vehicle's optics or electronics, rendering the interceptor impotent."[215]

In May 2000 another technical issue was raised. Ted Postal of MIT, a persistent critic of NMD, claimed that the government's June 1997 test of a ground based interceptor showed that the sensor was unable to discern the target from the decoys. Postal went even further charging that the military "attempted to hide this fact by tampering with both the data and analysis."[216] To make matters worse, the DoD classified Postal's letter on the grounds that it included three or four charts of classified data that had been inadvertently released to the public. In response to Postal's assault, the DoD stated that the system presently being considered for NMD was different that the one tested in 1997.[217]

The NMD had made technical progress in the late 1990s. In 1997 Boeing and in 1998 Raytheon conducted what the BMDO termed as successful fly-by tests of the system's exoatmospheric sensors, the first of which Postal referred to in his criticism. In December 1998 the NMD integrator (a joint venture made up of Lockheed-Martin, Raytheon, and TRW) picked Raytheon to build the kill mechanism. In October 1999 the

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[213] Two years earlier Helms suggested that the 1972 Treaty might not be valid due to the breakup of the Soviet Union, a position supported by a few other opponents of the treaty. Elizabeth Becker, "Right's Anti-ABM Weapon: A Senate Clause on Russia," *New York Times* (29Apr 2000); James Kitfield, "Rocket Science," *National Journal* (27 May 2000); Brian Knowlton, "Missile Defense Takes Center Stage," *International Herald Tribune* (28 Apr 2000), 1; Frank Wolfe, "Senate Would Reject ABM Agreement That Limits NMD, Republicans Warn," *Defense Daily* (20 Apr 2000), 1.

[214] Kitfield, "Rocket Science."

[215] See for example, Lisbeth Gronlund and Kurt Gottfried, "Missile Defense in a Vacuum," *Washington Post* (3 May 2000). "A Misdirected Missile Defense Plan," *Los Angeles Times* (30 Apr 2000), M4.

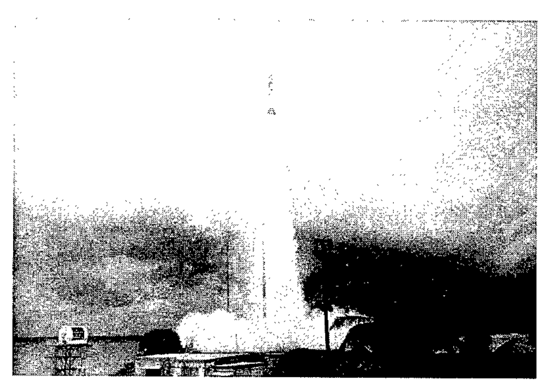
[216] "Missile Glitch," *Boston Globe* (20 May 2000); William Broad, "Antimissile System's Flaw Was Covered Up, Critics Says," *New York Times* (18 May 2000).

[217] William Broad, "Pentagon Classifies A Letter Critical of Antimissile Plan," *New York Times* (20 May 2000); Paul Richter, "Physicist Calls for Antimissile Inquiry," *Los Angeles Times* (19 May 2000).

testers achieved a real impact kill.[218] The critics' concerns appeared validated when the missile failed a January 2000 test. Although the 120-pound warhead got within 100 to 300 feet of the target, it nevertheless missed. With hit-to-kill warheads, close was not good enough. The developers believed that the two infrared sensors failed in the last six seconds of the mission due to a leak in their cooling system.[219]

The other perennial objection, cost, was also raised. In early April 2000 the Ballistic Missile Defense Organization director announced the first phase of the system would cost almost 60 percent more than prior estimates. This $20.2 billion would pay to develop, deploy, and support the 100-missile system in Alaska through 2025. Later that month the Congressional Budget Office released a study that also indicated that overall costs of the system were significantly higher than previously announced. (Their figures were over a different timeframe and for the much-expanded system, in any event, through the year 2015 would come to $60 billion.) While there were protests that this figure was too high, clearly costs were rising.[220]

At the time of this writing (June 2000), three major questions remain. First, there is the question of President Clinton's NMD deployment decision. Second, there is the question of what will happen to the ABM Treaty. Finally, will NMD or BMD become a campaign issue? But that is for another time and another study.



NMD launch in October 1999. Much more controversial than Theater Missile Defense, National Missile Defense became a highly charged issue. Credit: BMDO.

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[218] BMDO, Fact Sheet, "Ground Based Interceptor; Ballistic Missile Defense Organization, Fact Sheet, "National Missile Defense Integration Flight Test Three (IFT-3).

[219] Bill Bertz, "Cohen Touts Missile Test's 'Near Miss,'" *Washington Times* (29 Jan 2000); Tom Bowman, "Missile Failure Fuels Long-Running Debate," *Baltimore Sun* (20 Jan 2000); Bradley Graham, "Leak Foiled Missile Test," *Washington Post* (8 Feb 2000).

[220] Jim Abrams, "Report Puts $60 Billion Tag on Shield," *USA Today* (27 Apr 200); John Donnelly, "Missile Defense Costs 60 Percent More Than Advertised Price," *Defense Week* (3 Apr 2000).

Conclusion

What can we glean from this study of ballistic missile defense initiatives? As with so many other new weapons systems, missile offense took an initial lead over missile defense. Over the past 40 years this gap has grown. For, at the same time offensive ballistic missile systems have developed technically (with marked advances in range, power, and reliability) and spread geographically, defensive weapons have demonstrated neither reliability nor effectiveness. It is apparent that despite a need for such a defense and the appearance of various promising technologies, technical success has eluded the proponents of the system.

Throughout the debate, critics of BMD have been consistent. They have certainly emphasized technical failings and the impact of enemy countermeasures. But they have also raised other issues that include the negative influence of BMD on international politics, the unproven threat, and high cost. Clearly ballistic missile defense has been a high visibility issue over the decades, a highly political and controversial affair, in both the international and domestic spheres.

But despite this great visibility, this issue of ballistic missile attack and defense has primarily been one in the abstract. In fact, since 1945 there have been few casualties from ballistic missile attacks. From the outset, ballistic missiles have primarily served as a psychological weapon. At the strategic level they have acted strictly as a deterrent—no strategic missile has been fired in anger. At the tactical level, while there have been missile firings, casualties have been relatively low. Throughout, ballistic missiles have served more as a terror weapon than as a military weapon. Likewise, the most visible ballistic missile defense system, the Patriot, had its greatest impact as a psychological weapon.

The history of BMD efforts appears to counter the concern of those who fear the "technological imperative," that is, if it can be built, it will be built. The 1972 ABM Treaty limited a line of development. SDI was stopped, or certainly redirected, because of cost and politics. A number of BMD systems have been developed and tested, but a full-scale system has not yet been deployed for a variety of technical, economic, and political reasons.

What next? As we enter the twenty-first century the quest for an effective and affordable ballistic missile defense system continues at an increased pace. The impetus of proliferation, both of warheads of mass destruction (not only nuclear, but increasingly, chemical and biological weapons) and ballistic missile delivery system, together with the unsettled political arrangements in the post Cold War world, accelerates this process. At this point, there seems to be a growing distinction between TMD and NMD. While the first seems somewhat acceptable to decision makers in the US and abroad, the second is heavily criticized. The key objectives for BMD seem to be to demonstrate that the

technology will work, at an affordable cost (economically and politically), against a genuine threat. The systems' cost, visibility, and political (domestic and foreign) impact will guarantee that ballistic missile defense will continue to present a major issue in both Air Force and national military policy. If the past is any guide, ballistic missile defense will continue to be a long, costly, controversial issue.

Glossary

AAF	US Army Air Forces
ABM	Anti-Ballistic Missile
AUL	Air University Library, Maxwell AFB, AL
BMD	Ballistic Missile Defense
BMEWS	Ballistic Missile Early Warning System
BPI	Boost Phase Intercept
BUR	Bottoms-up-Review
CIA	Central Intelligence Agency
DDR&E	Director Defense Research and Engineering
DoD	Department of Defense
EMD	Engineering and Manufacturing Development
ERINT	Extended Range Interceptor
FABMDS	Field Army Ballistic Missile Defense System
FLAGE	Flexible Lightweight Agile Guided Experiment
GPAL	Global Protection Against Limited Strikes
HRA	Historical Research Agency, Maxwell AFB, AL
ICBM	Intercontinental Ballistic Missile
IOC	Initial Operating Capability
JCS	Joint Chiefs of Staff
LEAP	Light Exoatmospheric Projectile
LoAD	Low Altitude Defense
MAD	Mutual Assured Destruction
MEADS	Medium Extended Air Defense System
MPS	Multiple Protective Shelters
MSR	Missile Site Radar
MX	Missile Experimental
NATO	North Atlantic Treaty Organization
NBC	Nuclear, Biological, and Chemical
nm	nautical mile
NMD	National Missile Defense
NORAD	North American Air Defense (Command)
NTW	Navy Theater Wide
OTA	Office of Technology Assessment
PAC	Patriot Advanced Capability
PAR	Phased Array Radar
RSIC	Redstone Scientific Information Center, Redstone Arsenal, AL
SAC	Strategic Air Command
SALT	Strategic Arms Limitation Treaty

SAM	Surface-to-Air Missile
SDI	Strategic Defense Initiative
TEL	(missile) Transporter, Erector, Launcher
THAAD	Theater Area Air Defense
THEL	Tactical High Energy Laser
TMD	Tactical Missile Defense
TVM	Track via Missile
USSBS	United States Strategic Bombing Survey
V-1	World War II German air breathing (cruise) missile
V-2	World War II German ballistic missile

Conversions for English and Metric Measures

English to metric

Linear

1 inch	2.54 centimeters
1 foot	3.048 decimeters
1 yard	0.914 meters
1 mile	1.61 kilometers
also	
1 nautical mile	1.152 statute miles
1 nautical mile	1.853 kilometers

Weights

1 pound	0.454 kilograms

metric to English

Linear

1 centimeter	0.394 inches	
1 decimeter	3.937 inches	0.328 feet
1 meter	39.37 inches	3.28 feet
1 kilometer		0.621 miles

Weights

1 kilogram	2.205 pounds

About The Author

Kenneth P. Werrell is a Military Defense Analyst serving in Airpower Research Institute of the Air University College of Aerospace Doctrine, Research and Education. He graduated from the United States Air Force Academy in 1960 and went on to fly as a weather reconnaissance pilot. After resigning his commission in 1965, he entered Duke University graduate school where he earned both a masters and doctorate degree in history. He then worked as a contract historian for the USAF and as military historian for Operations Research, Inc. before going into university teaching. For 26 years he taught modern U.S. and military history at Radford University where he advanced to the rank of Professor. He came to his current position in 1999.

Professor Werrell has authored 20 articles and 5 books on military aviation history. Two of the latter were sponsored by the USAF: *The Evolution of the Cruise Missile* (1985) and *Archie, Flak, AAA, and SAM* (1988). His most recent book, *Blankets of Fire: the U.S. Bombing of Japan, 1944-45,* appeared in 1996.

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